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TABLE OF CONTENTS.

Engineering News of the Week 555

Technical Articles:

Tests of a Compound Locomotive in Fast Passenger Service (*illustrated*) 556
The Tunnels of the Baltimore Belt R. R. (*with inset*) 557
The Systematic Arrangement of Lights in U. S. Lighthouses (*illustrated*) 558
The Squantum-Moon Island Section of the Boston Sewerage Works 559
The U. S. Bureau of Yards and Docks 559
The Steel Skeleton Type of High Buildings.—II. (*illustrated*) 560
The Day System of Elevated Railway Construction (*illustrated*) 561
The Origin and Early History of the Camden & Amboy Railroad (*illustrated*) 561
Disputed Points in Bridge Design (*illustrated*) 563
Discharge of the Sudbury River Watershed (*illustrated*) 565
The Drainage of the City of Mexico (*illustrated*) 570
The United States Navy of 1891 571
The Electric Lighting of Warships (*illustrated*) 572
A Straightway Valve for High Pressure Steam (*illustrated*) 574
The Fuel Supply of the United States 575
The Compressive Strength of Brick 575
A safety Lock for Spring Rail Frogs (*illustrated*) 575
American Smokeless Powder 575
Paints—Their Composition and Purity 576

Personals, Society Proceedings 565

Editorial Notes 566, 567

The Interstate Commerce Commission Report—The Present Status of the World's Columbian Exposition—New York's Attitude Toward the Exposition—The Problem of Mechanical Flight—Report of the Bureau of Yards and Docks—The Report of the Secretary of the Navy—Interesting Points in the President's Message.

Editorial:

The Future of American Water-Works Construction 568

Correspondence 569

Free Instruction at the University of Minnesota—Large Siphons—The Indianapolis Cattle Guard Tests—The Fastest Train in the World—The Berliner Telephone Patent.

Construction News 576-578

Railways, City Transit, Highways, Bridges, Tunnels and Canals, Water-Works, Artesian Wells, Irrigation, Sewerage and Municipal, Electrical, Contracting, Proposals Open, Manufacturing and Technical.

THE BROOKLYN BRIDGE TRUSTEES, in their annual report for the year ending Dec. 1, 1891, show the following traffic and receipts:—During the year the receipts from tolls have been $1,176,447.95, divided as follows: Promenade, $8,221.02; carriageways, $79,255.59; railroad, $1,088,971.21. This is $49,353.45 more than was received from the same sources during the year ending Dec. 1, 1890. The number of passengers carried on the bridge cars was 39,766,043. The income derived from the railroad was $56,957.11 more than that of the previous year. The receipts from all sources for the year ending Dec. 1, 1891, were $1,829,785.43. This added to the balance on hand, which was $255,676.32, makes a total of $2,085,461.75. The expenditures amounted to $1,732,280.88, leaving a balance of $353,180.87. Of the $540,000 paid in on construction account, of which one-third was received from New York and two-thirds from Brooklyn, $21,643.85 was paid out to acquire title to real estate for the Brooklyn extension. For the real estate itself $476,000.06 was paid, and for labor, material, &c., in both cities $41,053.28 was paid. This leaves a balance on hand of $22,946.66. The rent roll on Dec. 1, including rents received from persons occupying stores under the arches in this city, and from 8 companies having telephone and telegraph wires on the bridge, was $104,318.74 a year.

CAPT. MAHAN'S NEW LIGHTHOUSE SYSTEM, described elsewhere in this issue, is to be practically tested by the Lighthouse Board. A fourth-order flash-light lens has been ordered from France for trial on Robbins' Reef, New York harbor. The lens will cost about $6,000, and the experiment will demonstrate whether or not numerical flashing signal lights can be substituted for the present mixed system.

THE BARBER ASPHALT CO. announce in a circular that they have laid in the United States over 5,000,000 sq. yds. of asphalt pavement, equal to 285 miles of roadway 30 ft. wide. They have laid 184,000 sq. yds. on top of old stone foundations, about equally divided between macadam and stone block foundations. They have also taken up and replaced with asphalt nearly 500,000 sq. yds. each of wood, stone and macadam pavement. The price, with guarantee for 10 years, is $3 per sq. yd. They also say with substantial truth: "Asphalt is not slippery when dry or when very wet, if free from mud. *Mud renders all pavements slippery.*"

AIR BRAKE PATENTS AND RIVALRIES have been brought before the public lately by two advertisements in the leading financial journals. In the first the New York Air Brake Co., capitalized at $5,000,000, offered for sale 6,000 shares of its stock at $65 per share, the brokers describing the investment as follows:

This company has acquired by purchase and is the sole owner of letters patent, taken out in the United States and in all the principal foreign countries, for an improved automatic compressed air brake (which is interchangeable with the Westinghouse), for use on engines, passenger and freight cars. These patents, after a thorough examination, have been pronounced by the ablest attorneys and patent experts as entirely free from infringement of any existing patents, and are at present in use on 80 different railways. The company is now turning out 30,000 car brakes and 2,000 locomotive equipments per annum, which, at present prices, show a net profit of $750,000 per annum. The stock now being offered is a part of 16,000 shares held in the treasury of the company, the remaining 10,000 shares to be used only for the future needs of the company and at a price not below par.

THE WESTINGHOUSE AIR BRAKE CO. inserted a statement in reply to this from which we extract the following:

We have brought suit against the New York Air Brake Co. and others who are attempting to make and sell a quick-action type of brake.

The opinion of our counsel, whom we believe to be equally as eminent and able as those quoted by the New York Co., and who has had charge of our patent affairs for twenty years, is to the effect that we hold controlling patents on the essential devices used by the New York Co.; and in view of the unquestioned record of the company in patent matters, we are confident of our position. That our position in these matters has weight with those who have placed orders with the New York Brake Co. is evidenced by the fact that they were obliged, as we are informed, to give heavy bonds to secure a leading railroad against loss, resulting from an enforcement of our rights, before the order was given to them.

The New York Air Brake Co.'s testimony (the defendants) in the pending suit is completed, and it is expected that the hearing will be during the February term of court in Pittsburg, at which time the relative value of the opinions expressed by the New York Brake Co.'s counsel and our own will be judicially determined.

Aside from any question of patents, the maintenance of constructive and operative uniformity of air brakes for freight trains that has heretofore existed is a matter of the utmost importance to the traveling public and to railroads. A departure from it means greatly increased liability to accident and a greatly reduced efficiency. These views are held by many leading railroad men who have given the matter thoughtful consideration, and there are several instances in which cars fitted with brakes that are not standard have been refused by railroad managers who did not care to assume the risk of injuring the efficiency of apparatus that they knew by experience to be in itself entirely satisfactory.

THE LAST CONTRIBUTION to the discussion is a card issued by the New York Air Brake Co., the substance of which is as follows:

Our brake device has been in service for 18 months upon cars which have been in the same trains with those equipped with the Westinghouse, and interchanging for months on numerous roads both in passenger and freight service, and the fact that the mechanical department of the Chicago, Burlington & Quincy Railroad, which had charge of the famous brake tests of 1886 and 1887, have adopted the New York Air Brake Company's brake and ordered 2,500 car equipments, is a sufficient guarantee of the interchangeability.

The very strongest evidence that we do not infringe any existing patents is in the fact that the Western Railway Association, after a thorough examination, has decided that there is no infringement whatever, and that railway companies can with safety use our device.

THE MOST SERIOUS RAILWAY ACCIDENT of the week and one of a very unusual character, being the collision of 4 trains, occurred Dec. 4 on the New York & New England R. R., at East Thompson, Conn., which is the junction of the Southbridge branch. A Southbridge local freight train had pulled on to the westbound track at about 6:45 A. M. and was standing on the track, when it was run into by a through eastbound freight train which had been switched on to the westbound track in order to get out of the way of the boat train and the New York & Eastern States express of the Long Island R. R., between Brooklyn and Boston, both of which were behind time. The wreck of the freight cars blocked both tracks, and was almost immediately run into by the Long Island express, the engine of which was overturned, while the 4 cars remained on the track. The engineer and fireman were killed. The boat train generally runs ahead of the express, but being late had been held at Putnam for the latter to pass. One of the brakemen of the express started back to flag this train, but was not in time to get far from the wreck, and the engine driver could not stop the train, which smashed the rear Pullman car of the express, while its own baggage car was telescoped by the tender. The Pullman car caught fire and was destroyed, and one of the passengers was either killed by the collision or burned. Altogether 3 men were killed and 7 were injured. All the engines were wrecked, and a large number of cars were wrecked and burned. The primary cause of the disaster was evidently the running of an eastbound train on the westbound track, while its seriousness was increased by the haphazard way in which all the trains appear to have been run.

BRIDGE AND TRESTLE ACCIDENTS are reported as follows: On Nov. 28 the falsework of an uncompleted 60-ft. span of the Great Northern Ry. bridge over the north fork of the Columbia River, near Columbia Falls, Mont., gave way owing to the falling of some iron work against the supports. Three men were killed and 3 fatally injured. A bridge on the Findlay, Fort Wayne & Western R. R. near Ottawa, O., gave way under a construction train Dec. 5, and 3 men were killed. A derailed passenger train on the Louisville, New Orleans & Texas R. R. broke through a trestle near Evansville, Miss., Dec. 5; 9 persons were injured. A highway bridge across Big Pine Creek, in Lamar Co., Tex., gave way under a team Nov. 30. The driver was seriously injured.

THE CLEVELAND GAS WAR, in which the city is contending for a 60-cent rate, has developed the fact that the gas company has watered its stock from $100,000 to $2,500,000 in the 40 years its charter has been running, and that it now pays no less than 150% annually on all the money ever actually invested in the plant. All the extensions have been made out of profits. The gas is now, and for a number of years has been, adulterated with naphtha; and unnecessary pressure is used so that gas is forced through the burners so rapidly as to prevent proper combustion, thereby causing increased cost to the consumer.

WHILE THE TRANS-SIBERIAN RAILWAY has been mapped out over the whole route, only one-half of it is said to be properly surveyed, or about 2,500 miles in all. Report has it that a party of engineers have recently left St. Petersburg to complete the survey. The longest completed survey is across the plains of central Siberia, where few engineering difficulties are encountered. For 1,200 miles east of Lake Baikal the work is completely done, and about 200 miles at the extreme eastern end are also finished. The west end, between the slope of the Ural Mts. and the Obi River, is still to be surveyed. The latest estimate figures the total cost of the railway, including bridges, stations and rolling stock, at $175,000,000.

A NEW PROCESS FOR PROTECTING IRON AND STEEL is now being carried out at the works of Joseph Westwood & Co., at Millwall, England, says *The Engineer*, from which we abstract as follows: This is known as the electro lead process, the sole reason for appending the word "electro" being that before dipping the plates are put in a pickling bath through which passes a weak current of electricity. This pickling bath contains about 10% of hydrochloric acid and 1% of hydrofluoric acid, at a temperature of 120° F. The object is then transferred to a tank of lime water at the same temperature, and thence to a solution of stannous chloride and zinc chloride, also kept warm, and finally to a bath of metallic lead. This lead coating is claimed to be an efficient protection. Bending and twisting will not separate the lead from the iron and steel. The cost compares favorably with that of galvanizing, and tests show no loss of tensile strength due to the coating. The lead is readily removed by abrasion, however.

Tests of a Compound Locomotive in Fast Passenger Service.

In our issue of Dec. 27, 1890, and Jan. 3, 1891, a full account was given of exhaustive tests made on a compound locomotive built for the Union Elevated R. R., Brooklyn, N. Y., by the Rhode Island Locomotive Works, of Providence, R. I. The engine was run in comparison with a simple engine of practically the same dimensions in every respect; and the compound showed a fuel consumption 37.7% less and a water consumption 23.8% less than the simple engine. The tests were made in service runs on the Union Elevated R. R., each engine making 24 trips with three and four car trains. The total duration of the test was about 10 hours.

The test showed, as will be seen by reference to the report above referred to, many excellent features of the compound locomotive for elevated railway service besides its superior economy in fuel. Some tests have recently been made of a compound locomotive from the same builders, but designed for fast express service. The results showed an advantage in fuel economy with the compound of 22½% on the average. The tests were carried out on the New York, Providence & Boston and the Boston & Albany railways, an ordinary locomotive from each road being selected to run in competition with the compound.

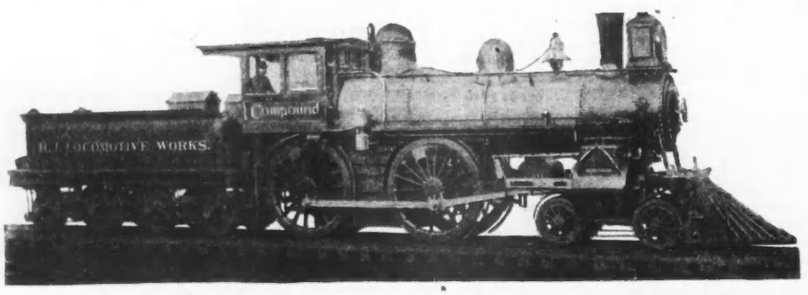


FIG. 4. PERSPECTIVE VIEW OF COMPOUND LOCOMOTIVE, RHODE ISLAND LOCOMOTIVE WORKS.

Fig. 4 is a perspective view of the compound locomotive, which was No. 2,600, built by the Rhode Island Works. It was designed for making fast time with a train making few stops on a road with level surface, or short and light grades. The plain engines used in competition with it were No. 34, New York, Providence & Boston, and Nos. 136 and 173, Boston & Albany R. R., the two latter being duplicates of each other. All the engines had nearly the same dimensions, as shown by Table I. The compound had a very little advantage in heating surface, but had a disadvantage in tractive power, which counted against it on the steep grades of the Boston & Albany. The compound locomotive, at the will of the engineer, may also be run as a simple engine, taking live steam from the boiler in both cylinders, that for the high pressure cylinder exhausting into the atmosphere, and that for the low pressure cylinder being wire-drawn through a reducing valve to a lower initial pressure so that the work done by both cylinders shall be the same.

All the data of the tests results of which are summarized in Table II. were verified by the motive power officials of the different roads.

SERVICE.

The compound locomotive No. 2,600 has been in successful general service on all the heavy and fast trains on the New York, Providence & Boston R. R. between Providence and New London, a distance of 64 miles. The terminals are at tidewater and the intervening road has a rolling surface, there being grades each way from ½ to 1%. The line of road is practically straight. The first four lines of Table II. show the results of competitive trials on two of these trains. On the 6-trip series of tests on this road the water consumption was measured, and the results are shown in Table III.

The service on the Boston & Albany R. R. was between Boston and Springfield, a distance of 99 miles, and was of a different nature from that on the New York, Providence & Boston R. R. The road ascends from Springfield to Charlton, 42 miles, with a total rise of 835 ft., and then falls to tidewater at Boston. The steepest grades on this road have bad curves. In making the schedule time between the terminals, advantage cannot be taken of the down grades to the extent of over 42 miles per hour; and the making up of lost time is limited to 5 minutes each between Worcester and Springfield and Worcester and Boston. Thus the time which an engine designed for a more level road might lose on a bad up grade could not be made up on the down grades; and but 5 minutes could be made up on the levels. In order to make the running time, therefore, little time can be lost on the hills. The compound, as before mentioned, is not designed for this class of service; but, as will be seen by Table II., it had no difficulty in making its time with the other engines. Its ability as a hill climber was fully recognized after its experience with these trains. This was due to its excellent staying qualities when worked to full capacity as a compound, together with its ability to get under way quickly from a bad starting place by working as a simple engine.

TABLE I.—DIMENSIONS OF LOCOMOTIVES.

	Compound,	Simple	
	2,600.	N. Y., P & B. 34	B. & A. 173 and 136
Cylinder: Right side, ins.	28 × 24	18 × 24	18 × 22
" Left side, ins..	18 × 24	18 × 24	18 × 22
Diameter of drivers, ins.	78	72	70
" of boiler, ins..	52	52	52
" (outside) of flues, ins...	2	2	2
Number of flues.....	214	200	221
Length of flues.....	10 ft. 10 ins.	11 ft. 10¾ ins.	11 ft.
Grate (cast iron rocking), ins.....	78⅛ × 34⅜	72⅛ × 34⅜	71⅛ × 35¼
Grate area, sq. ft.....	18.65	17.72	17.41
Heating surface: Total, sq. ft.....	1,243.83	1,236.63	1,236.62
Heating surface: Fire-box, sq. ft.....	157.57*	120.95	116.78
Heating surface: Flues, sq. ft.....	1,086 26	1,115.68	1,119.84
Ratio: Heating surf. to grate.....	66.69	69.78	71.02
Total weight, loaded, lbs.	103,250	91,250	91,000
Weight on drivers, lbs...	66,520	60,200	61,500
" " truck, lbs....	36,710	31,050	29,500

*Including 19.63 sq. ft. fire brick tubes.

CONDITIONS OF TESTS.

The competing engines on each trial were run on the same trains, the same number of days, with the conditions as nearly alike as possible, the same engineer handling each engine, and enough days being taken to insure a fair average. The engineers had no experience with the compound previous to the first day of each test, but were regular runners on the competing simple engine, with the following exception: on the 6-trip trials on the N. Y., P. & B. the engineer had No. 34 but a few days before the test. The runs on the Boston & Albany R. R. were exceptionally hard for each engine, as the road was undergoing repairs in numerous places between Boston and Springfield, which necessitated many slow-ups and extra stops.

On the New York, Providence & Boston R. R. the conditions were very similar for each engine on each trial, with the exception of the runs with the compound on two round trips of the 3-trip tests. The train being an hour late from New London was obliged to make extra station stops, besides stopping for several signals and slowing up for the suburban trains at stations near Providence. This affected the elapsed time between New London and Providence, and also the general average of running time.

COAL AND WATER CONSUMPTION.

The coal economy, as given in Table II., is based on car mileage. The results are practically the same when based on ton mileage. Coal was weighed to the engine at the beginning of each trial, there being a low fire and no coal on the tank; that used by each engine includes the banking for over night. At the finish of the last run of a series, the fire was allowed to burn low, and the remaining coal in the tank was weighed back. The coal account, in all cases, was kept by an employee of the railroad company. The quality of coal on the New York, Providence & Boston R. R. was ordinary bituminous, about one-half lumps. The coal used on the Boston & Albany R. R. was best quality of Pocahontas, well mixed with lumps.

TABLE III.—RECORD OF WATER CONSUMPTION IN THE 6-TRIP TESTS ON THE N. Y., P. & B. R. R.

Engine.	Evaporated in boiler, galls.	Used in cylinders, galls.	Lbs. evaporated per lb. of coal.	Percentage water saved, used in cylinders.
No. 34.....	25,140	25,087	6.59 from 43.2°	
Compound ...	23,812	23,706	7.30 " 53.25°	5.5%

Accurate water measurements were attempted on but one test, objection being made to the delay incident to taking accurate readings when water is taken on the line of the road. From the observations which were made, however, there is every reason to believe that the trial in which the water was measured was the one in which least was saved. This would follow from the fact that it was the lightest of the four tests in point of work done, and was that in which the least coal was saved.

On the test in which water was measured, careful at-

TABLE II.—COMPARATIVE TESTS OF COMPOUND EXPRESS LOCOMOTIVE, BUILT BY THE RHODE ISLAND LOCOMOTIVE WORKS, AND SIMPLE LOCOMOTIVES.

	Schedule time, round trip.	No. round trips averaged.	Av. weight of trains empty, net tons.	Engine.	Total car mileage.	Total coal, net tons.	Coal used per car mile, lbs.	Percent'ge of coal saved.	Average running time. Prov. to N. Lon.	Average running time. N. Lon. to Prov.	Average miles per hour. Prov. to N. Lon.	Average miles per hour. N. L. to Prov.
Tests on N. Y., P. & B. R. R. Providence to New London and return, 128 miles.	3 h. 21 min.	3	.....	No. 34.....	2,752	12.27	8.91	.....	1 h. 38.6 min.	1 h. 39 min.	39.25	38.88
			.....	Compound..	2,752	9.17	6.66	25.2%	1 h. 39.6 min.	1 h. 44 min.	38.63	37.21
	3 h. 10 min.	6	.....	No. 34.....	4,608	15.9	6.9	.....	1 h. 31 min.	1 h. 27.3 min.	42.84	44.72
			.....	Compound..	4,608	13.59	5.9	14.52%	1 h. 30.7 min.	1 h. 27 min.	43.04	44.84
									Bos. to Spring.	Spring. to Bos.	Bos. to Spring.	Spring. to Bos.
Tests on B. & A. R. R.: Bos'n to Springfield and return, 197 miles	5 h. 28 min.	9	145 8	No. 136.....	8,372.5	39.5	9.43	.....	2 h. 36½ min.	2 h. 43½ min.	37.75	36.2
			144.1	Compound..	8,613.5	29	6.73	28.63%	2 h. 37⅝ min.	2 h. 39½ min.	37.51	36.32
	5 h. 22 min.	7	187.2	No. 173.....	8,718	30.5	6.99	.....	2 h. 37¼ min.	2 h. 38 min.	37.59	37.39
			184.1	Compound	8,565	23.5	5.48	21.6%	2 h. 37.4 min.	2 h. 39 min.	37.53	37.18

tention was paid to the measuring of all quantities not used in the cylinder, and high water in the boiler was guarded against. The water in the boiler water glass was at the same place when final tank reading was taken at the end of the round trip as when the first reading was made, the engine standing at the same spot.

GENERAL SUMMARY.

Reference to Table II. shows a saving in fuel consumption by the compound of 14.52% to 28.63%, running in competition with selected engines on the respective roads; the engineer in each case being the regular runner of the simple engine, but handling the compound for the first time. The engineers all claimed that they could do more justice to the compound on a longer acquaintance.

All the engines were as nearly alike as was possible under the circumstances, the cylinder action excepted; and the differences in heating surface alone were too small to affect appreciably the fuel consumption.

The compound has met satisfactorily all requirements of hard work and fast running that have been placed upon it. In point of cleanliness, *i. e.*, freedom from cinders and black smoke, the compound is a marked contrast to the simple engines. This feature was quickly observed and remarked by the engineer and trainmen on the first trips on each new train. From this fact the question naturally arises why the compound could not be substituted for the large and heavy anthracite coal burners which are run at large expense and considerable trouble on some fast trains simply on account of the item of cleanliness. The compound No. 2,600 needs and has no netting in the front end.

If the compound locomotive can be run so that the smoke and cinder nuisance is satisfactorily dispensed with, which would seem to be the case, the cost of operating it as compared with an anthracite coal burner may be illustrated from an actual case as follows: Trains 23 and 42, N. Y., P. & B. R. R. (those with which the 3-trip tests of Table II. were made), have an anthracite locomotive for a regular engine; it runs 29.5 miles per ton of coal as a regular average. Another anthracite locomotive on a somewhat lighter service on the same road, runs 30.5 miles per ton. Comparing the cost of anthracite fuel on trains 23 and 42 with the cost of bituminous fuel used by the compound on same trains (42 miles per ton), the saving in cost is 48%, the bituminous coal costing 26% less, delivered, than the anthracite.

It is claimed that in a properly designed compound locomotive the stress effects of the reciprocating and revolving parts should be more regular than in a simple engine exerting the same power. This was fully explained with diagrams in our article on the Brooklyn Elevated R. R. locomotives, referred to above. No. 2,600 has never shown a suggestion of heating in any of the bearings or journals, all of which are of the ordinary size. The fastest and hardest work has called for but the most ordinary care in the lubrication of parts. The voluntary verdict of all the engineers is that it is an uncommonly cool running locomotive, light on oil and easy to take care of, the latter, in their estimation, being quite a point in the compound's favor.

The ability of this type of compound to be run as a simple engine enables it to be run with either cylinder singly, in case of break-downs, with no more trouble than an ordinary engine.

No. 2,600 has so satisfactorily met all requirements of heavy and fast express service that have been placed upon it for several consecutive months that the builders believe themselves justified in claiming as a conservative estimate, a saving of 15% to 25% of fuel on express service by a properly proportioned compound of this type, in competition with a simple locomotive, the amount of saving depending on the service; they claim also a decided advantage in cleanliness and freedom from heating tendencies, the latter signifying light oil consumption.

The intercepting valve in use on No. 2,600 is the invention of Mr. C. H. BATCHELLOR, Chief Draftsman of the Rhode Island Locomotive Works, and was patented Sept. 22, 1891. Figs. 1, 2 and 3, illustrate this valve, the action of which is explained as follows: The intercepting valve being in any position, as that shown in Fig. 2, and the throttle being opened, boiler steam will pass to the h. p. cylinder in the usual manner, and also through pipe *D* into the intercepting valve *A*, causing the piston to move into the position shown in Fig. 3. In this position the receiver is closed to the l. p. cylinder by the piston *c*, and steam from *D* passes through ports *d* and *e* and reducing valve *B* into the l. p. steam chest, the pressure being reduced from boiler pressure in the ratio of the cylinder areas. The piston *a*, *b*, *c* is so proportioned that it will automatically change to the compound position, shown in Fig. 2, when a predetermined pressure in the receiver *E* has been reached by exhausts from the h. p. cylinder. The engine thus starts with steam in both cylinders, and automatically changes to compound at a desired receiver pressure.

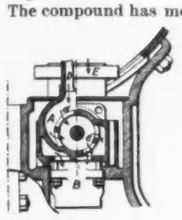


Fig. 1.

Cross-Section of Intercepting Valve at Ports d and e.

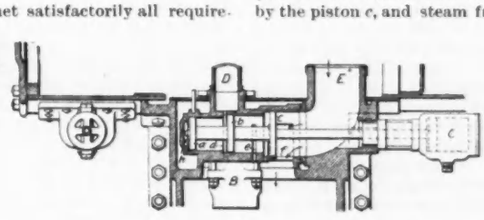


Fig. 2.

Position for Running Compound.

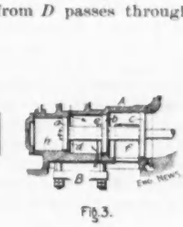
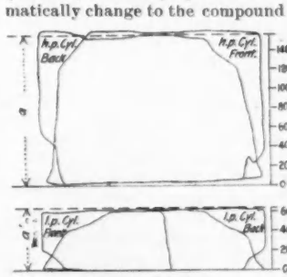


Fig. 3.

Position for Running Simple.

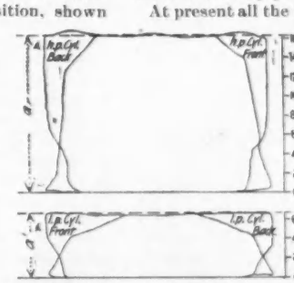
LONGITUDINAL SECTIONS OF INTERCEPTING VALVE.

A. (Figs. 1, 2, 3), Intercepting Valve Casing. B. (Figs. 1, 2, 3), Reducing Valve. C. (Fig. 2), Oil Dash-Pot. D. (Figs. 1, 2), Pipe from Main Steam Pipe to Intercepting Valve. E. (Figs. 1, 2), Receiver. a, b, c (Figs. 1, 2, 3, Intercepting Valve Pistons. d (Figs. 1, 2, 3), Port from D through A. e (Figs. 1, 2, 3), Port from A into Reducing Valve B. f (Figs. 2, 3), Port from A into Passage to l. p. Steam Chest.



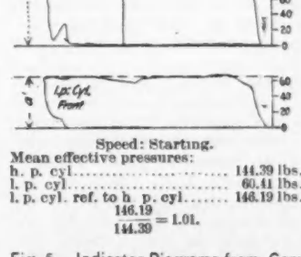
Speed: Starting.
Mean effective pressures:
h. p. cyl..... 136.87 lbs.
l. p. cyl..... 53.58 lbs.
l. p. cyl. ref. to h. p. cyl ..... 129.66 lbs.

$$\frac{129.66}{138.87} = .95.$$



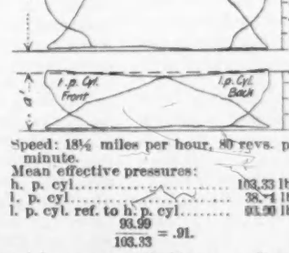
Speed: 14 miles per hour, 60 revs. per minute.
Mean effective pressures:
h. p. cyl..... 144.27 lbs.
l. p. cyl..... 56.46 lbs.
l. p. cyl. ref. to h. p. cyl..... 136.63 lbs.

$$\frac{136.63}{144.27} = .94.$$



Speed: Starting.
Mean effective pressures:
h. p. cyl..... 144.39 lbs.
l. p. cyl..... 60.41 lbs.
l. p. cyl. ref. to h. p. cyl..... 146.19 lbs.

$$\frac{146.19}{144.39} = 1.01.$$



Speed: 18¼ miles per hour, 80 revs. per minute.
Mean effective pressures:
h. p. cyl..... 103.33 lbs.
l. p. cyl..... 38.74 lbs.
l. p. cyl. ref. to h. p. cyl..... 93.99 lbs.

$$\frac{93.99}{103.33} = .91.$$

Fig. 5. Indicator Diagrams from Compound Locomotive Working as a Simple Engine. High Pressure Cylinder Exhausting into the Atmosphere and Low Pressure Cylinder Taking Steam from the Boiler Through a Reducing Valve.

The engine may be changed from the compound system to the simple at any time at the will of the engineer by opening a valve connecting the receiver to the exhaust pipe, allowing the exhaust steam from the h. p. cylinder to be ejected through the exhaust nozzles in the usual manner. The operation of this exhaust valve permits receiver pressure to enter *h*, in order to insure the movement of the piston to the position of Fig. 3., before the receiver is emptied through the exhaust. This insures against a lapse of continuous action in the h. p. cylinder during the change from the compound to the simple system while running.

It is obvious that in case of bad conditions of starting, the engine may be operated as a simple one at the will of the engineer by opening the exhaust valve before starting; and that upon its closure, the piston *a*, *b*, *c*, will automatically take the compound position of Fig. 2, as described above.

Fig. 5 shows indicator diagrams taken from the compound locomotive when working as a simple engine. The lines *a*, *a'* to the left of the diagrams are added to show how closely the reducing valve regulates the work done in the l. p. cylinder to correspond to that in the h. p. cylinder. When the h. p. piston has the pressure *a*, the l. p. cylinder, on account of its greater area, should have the pressure *a'* in order to do equal work. The low pressure cards show the positive and remarkably even action of the reducing valve in regulating the pressure.

The Baltimore Belt Railroad.

(WITH INSET.)

On Dec. 17, 1888, a company was chartered to build a railway in the city of Baltimore from the Camden station of the Baltimore & Ohio R.R. north through the heart of the city, and thence turning east to a connection with the Philadelphia extension of the Baltimore & Ohio. The enterprise was planned by officers of the Baltimore & Ohio and Western Maryland railways, being intended to give those roads facilities for reaching the heart of the city with their passenger and merchandise traffic equal to the facilities enjoyed by the Pennsylvania R. R.

At present all the trains over the Philadelphia division of the Baltimore & Ohio R. R. enter and leave Baltimore by ferry transfer across the west branch of the Patapsco river, from Canton to Locust Point, about three-quarters of a mile. They then run nearly four miles farther through the railway yards, and along the streets of South Baltimore to the Camden station. The distance to Camden station by the Belt Railroad will be about one mile more than by the present ferry connection; but there will, of course, be no comparison between the two routes as to convenience.

A franchise was secured from the city of Baltimore in the early part of 1890, in accordance with the provisions of a special act passed by the Maryland Legislature, March 18, 1890, providing for the construction of the road.

To provide capital for carrying on the work, the Maryland Construction Co. was organized by officers of the railways interested and Baltimore capitalists, the President being Mr. JOHN B. MCDONALD one of the present contractors.

Proposals for the construction of the road were received from a large number of contractors, and on Sept. 4, 1890, the contract for the construction of the whole line ready for the laying of the track was

awarded to the well known contracting firm of Ryan & McDonald, with the exception of Section 3, from York Road to North Ave., about 6,600 ft., which was let to L. B. McCabe & Bro., of Baltimore. The total estimated cost of the road, seven miles in length, was about $6,000,000. The estimated cost of the Howard St. tunnel, 8,350 ft. in length, was $1,750,000. The land damages were estimated at $1,000,000. Bonds were issued to provide funds for the work to the amount of $6,000,000. They bear interest at 5%, making the annual fixed charges of the company $300,000.

In our issue of June 28, 1890, a description of the road was published, with a map and profile of its location.

The route followed by the line is the same as was shown on that map, except that a few changes in alinement have been made on account of difficulties in securing rights of way. On no part of its course is the road located along the surface of streets or avenues; grade crossings are everywhere avoided; and where the road passes through the business section of the city, it is wholly in tunnel.

Section 1 extends from the Philadelphia division of the Baltimore & Ohio at Bay View Junction, to Belair Road on the edge of the Johns Hopkins University grounds. There are two 5° curves, and the road ascends on an 0.8% grade.

At Bay View Junction a fill has been made wide enough for 8 tracks, and this will be utilized for yard purposes. All masonry and bridges are made for two tracks of the standard Baltimore & Ohio section (shown in our issue of Oct. 31). The length of Section 1 is about 1,100 ft.; and the work on it comprises 450,000 to 500,000 cu. yds. earth excavation (depending upon number of additional tracks decided upon), iron girder bridges of 30, 50 and 60-ft. span, masonry abutments for these three bridges, and masonry arches of 12-ft., 8-ft., and two of 30-ft. span. The total masonry is about 5,800 cu. yds., all of which is in place. The work still to be done includes 200,000 to 300,000 yds. of excavation and the erection of the iron bridges.

Section 2 extends across the Johns Hopkins University grounds and thence west to the end of the York Road tunnel. There is one 1° curve and grades from level to 0.8%. Nothing has been done on this section except at the York Road tunnel, about 300 ft. in length, where work is in progress with a semicircular roof shield, which we shall describe in a following issue. The masonry on this section will consist of two small culverts and the arching over of the line where it passed underneath Harford Road.

York Road tunnel is the summit of the line, and from its west end Section 3 extends west and south to North Ave., with a falling gradient of 0.5% to 1.5%. The change in alinement is made with two 8° curves. It is on this section that connection will be made with the Maryland Central Railroad, and Contractor McCABE has done part of the grading for the connecting line.

The principal work on this section is the bridge across Jones' Falls and the tracks of the Northern Central and other railways just west of the present Union station. This bridge will have 5 spans, of which two will be 80-ft. deck girders, two will be 70 ft. half-through girders, and the other will be a half-through girder for a span 83 ft. between pier centres. Only one abutment and a couple of piers for this bridge are completed. On the eastern half mile of this section the rail level is 20 to 40 ft. below the general level of the surface. The excavation will all be made in open cut and afterward will be arched over at Barclay St. and at Guilford Ave., and also west of these to form two short tunnels, each about 500 ft. long. Besides the work above noted, the contractor has finished an arch culvert across Edwards Run. In explanation of the apparently small amount of work done on the first three sections, it should be said that work on them is almost blocked by right-of-way litigation.

It is on Section 4, however, that the chief difficulties in construction center, and it is here that Ryan & McDonald have concentrated their forces. The section extends from the Jones Falls bridge south to the terminus at the Camden station of the Baltimore & Ohio, about 11,000 ft., running underneath the principal business section of the city by a tunnel 8,350 ft. in length. This tunnel is claimed to be the largest soft-ground tunnel ever driven. Its section after lining is 27 ft. wide and 22 ft. high, maximum dimensions; and the excavation necessary is from 3 to 5 ft. larger than this. Even in rock tunnels this section has been seldom exceeded.

The distance of the crown of the tunnel below the surface is about 70 ft. at the deepest point. The soil through which the tunnel is driven is chiefly sand of varying degrees of fineness; but intermingled with it are seams of gravel, clay and loam of various classes. Some clay has been encountered too hard and tough to be excavated with a pick, and it had to be blasted. On the bottom of some of the shafts a layer of rotten rock three or four feet thick has been excavated. All the material furnishes more or less water to the tunnel, but the main flow comes from an 8-ft. stratum of gravel, which seems to underlie a considerable portion of the city, and in which there is a strong current flowing from east to west.

As the city of Baltimore is rather poorly supplied with sewers, advantage has been taken of this gravel stratum for purposes of "sewage disposal." In some parts of the city every house has a well leading down to this gravel stratum, and into this well all the wastes of the house are turned. As the tunnel has advanced, the wells adjacent to it have gradually been drained. This and the presence of certain acids in the water has proved conclusively that a large portion of the water encountered in the tunnel is sewer water. It was feared at first that this might cause illness among the workmen; but such has not been the case. The water as it enters the tunnel, notwithstanding its source, is generally quite clear and free from odor; and the health of the workmen employed in the tunnel has been excellent.

The difficulties in carrying on the work, however, are due to its location as well as to the character of the ground. Howard St. is one of the principal business streets of the city, with buildings on each side 3 to 8 stories high. One of Baltimore's recently built cable railways runs through the street from Fayette St. to Lombard St., three blocks, and a double track horse railway runs nearly the whole length of the street, over the tunnel. There is also a great deal of traffic through the street, many of the vehicles being heavily loaded trucks.

In planning for the driving of the tunnel, therefore, it was considered of much importance to avoid obstructing the street. Shaft No. 1, near the north end of the tunnel, is placed in a vacant lot, and shaft No. 2, near the south end, is located in the street. Shafts 3, 4 and 5, numbered in the order of their construction, are between these, and are all driven to one side of the line of the tunnel from the cellars of buildings on the street. Horizontal drifts connect the bottom of the shafts with the tunnel.

On our inset sheet this week we show drawings of each of these shafts, for the originals of which we are indebted to Mr. H. B. REID, Chief Engineer for the contractors.

SHAFT NO. 1.

While the main portion of the tunnel is on Howard St., the northern portion, about half a mile in length, runs underneath the blocks to continue on the same tangent course, the streets in this part of the city being laid out at angles of 45° to those further south. The alinement north from Hoffman St. has recently been changed to avoid heavy land damages at the northwest corner of Dolphin St. and Mt. Royal Ave. Two 10° curves have been introduced, throwing the line to the east and changing somewhat the profile from that shown in our issue of June 28, 1890.

A vacant lot directly over the line of the tunnel at Park Ave. and Preston St. was purchased by the company and Shaft No. 1 was sunk upon it. As the ground was easy, the depth small, and the convenience of abundant room considerable, this shaft was made 30 ft. × 10 ft. in section, extending across the full width of the tunnel outside the lining. It has two elevator wells and a well for lowering long timbers. The machinery at this shaft includes an 8 × 10-in. Otis vertical hoisting engine for running the elevator cages, a horizontal hoisting engine for lowering long timbers, an electric light engine and dynamo, and an 18 × 24-in. Ingersoll-Sergeant air compressor. The work done by the latter will be more fully explained next week. The distance from the ground level to the tunnel bottom is 46 ft. at this shaft and to the soffit of the arch is 24 ft.

SHAFT NO. 4.

This shaft, the next one south of Shaft No. 1, was driven through the cellar of a building on the east side of Howard St., near Madison St. Its total depth is about 65 ft. from the cellar floor to the bottom of the sump. The total height of hoist is 75 ft. The horizontal dimensions of the shaft are 9 ft. × 14 ft. inside of timbers. The shaft is divided into two compartments, the elevator well and a well for lowering long timbers. The elevator cage is counterbalanced. The drawing shows very well the dogs used for holding the elevator cage at the stopping points. These are hinged wooden bars which can be held upright or turned down against a stop-block when it is desired to hold the elevator cage. As the cage rests on these, the rails on its floor are at the same level as the rails on the drift levels and on the run-off tracks, and the cars are rolled smoothly on or off. The derrick for hoisting long timber is worked by a Ryan & McDonald hoisting engine, and there is also a hoisting engine for running the elevator, and an electric light engine and dynamo, besides the boilers necessary to furnish steam. The cars as they come up the shaft with the excavated material are run off to the right, on the second story of the building, and dumped through a chute into carts below. In these carts the material is hauled about a mile to the B. & O. R. R. and deposited on cars. It is then hauled by train about 8 miles and used for filling.

It will be noticed that the drift from the bottom of this shaft to the tunnel has two levels, and the upper deck is carried into the tunnel for a short distance. This greatly facilitates handling the timber and excavated material. The truss in the tunnel is supported on the brick lining.

One other noticeable feature of this shaft is the excavation of a separate chamber back of the shaft for the pump.

SHAFT NO. 3.

The peculiar building from which this shaft is driven will be noted. It was formerly the private stable of the GARRETT family, and it is quite appropriate that it should now be made of use in connection with an enterprise intended to benefit the Baltimore & Ohio R. R. The arrangement of this shaft is similar to that of No. 4. There is a single elevator well, with counterbalanced cage, and a well for lowering timber (located at the back of the elevator well, so that it does not appear on the drawing). The tunnel is entered through a single level drift, the timbering of which is somewhat different from that elsewhere used. The roof bars are supported by segment timbers resting on a wall plate at the springing line of the arch, as illustrated in the cross-section of the drift.

SHAFT NO. 5.

The shaft was sunk at Saratoga St., within 4 ft. of the foundation of a very large building. It is quite shallow, however, the top of the tunnel excavation being only 11 ft. below the surface of the pavement. The entrance drift has two levels, as at Shaft No. 4; but no elevator cage is used, the excavated material being hoisted to the surface in iron buckets which are swung to one side by the derricks and dump directly into the carts on the street level. The shaft has but one well, the timbers being lowered by the same derrick which hoists the buckets. The only machinery at this shaft is a hoisting engine, current for the electric light being furnished from the dynamos at Shafts 2 or 3. It will be noticed that the entrance drift and the tunnel run within five or six feet of a 3-ft. brick sewer.

SHAFT NO. 2.

This is the shallowest of the five shafts, and is the only one located in the street. The top of the tunnel excavation is only 9½ ft. below the surface of the pavement. The shaft is located near German St., about 1,200 ft. from the south terminus of the tunnel at Camden St. As the cable railway runs through Howard St. at this point, the shaft had to be set to one side of the center line of the tunnel. The horse-car track was moved over next to the curb, and the shaft was sunk between the tracks. The shaft has a single elevator well, without counterbalance, and a well for lowering long timber. The machinery for working this shaft is located in an adjoining building as shown, the hoisting ropes running to the headhouse over the shaft at a sufficient height to clear the sidewalk.

All the elevators at the different shafts are con-

trolled from the surface; connections being made from the hoisting engine to the mouth of the shaft, as shown in the drawings. Safety-catches are used on all elevators. Otis Bros., of New York City, furnished the elevators for Shafts Nos. 1, 2 and 3. Bates & Co., of Baltimore, furnished the machinery at Shaft 5.

(To be continued.)

The Systematic Arrangement of Lights in U. S. Lighthouses.

We have already briefly noted the plan proposed by Capt. F. A. MAHAN, Corps of Engineers, engineer Fourth Lighthouse District, and engineer secretary of the Lighthouse Board, for the systematic arrangement of lights in United States lighthouses. From the latest circular of the Lighthouse Board we are enabled to more fully explain this system as follows:

The purpose of the proposed change is to enable the navigator, coming suddenly upon a light, to at once and certainly ascertain what light it is and to what establishment it belongs. In the study of this matter the whole Atlantic coast, from the St. Croix River, in Maine, to the Rebecca Shoals, at the west end of the Florida Reefs, has been carefully examined. In this distance there are 61 off-shore light stations, not counting lightships. Of these 61 stations, 28 have fixed white lights, 28 have lights with characteristics, three have a double group of fixed white lights, one has a treble group of fixed lights, and one a fixed and flash light.

These 61 stations have distinguishing marks in only 29, and in these latter there are only five characteristics in 16 lights. This leaves a chance for confusion. To correct this difficulty, Capt. MAHAN proposes the following system: Eliminate from all off-shore lights all red elements, and make at least one red element the distinguishing feature of each in-shore light. Then give to each off-shore light some characteristic. The system of time intervals between flashes is unsatisfactory on account of the difficulty of timing these intervals when the ship is pitching or rolling heavily; atmospheric influences cause apparent variations, and barometric changes affect the wings of the governors of the driving mechanism. In its place, therefore, is proposed a system of numeral characteristics, or the assignment of a number to each light, with the number to be indicated by a group of flashes. For example, Light No. 134 would be indicated thus: — --- ----, or by three groups of flashes separated by a partial eclipse.

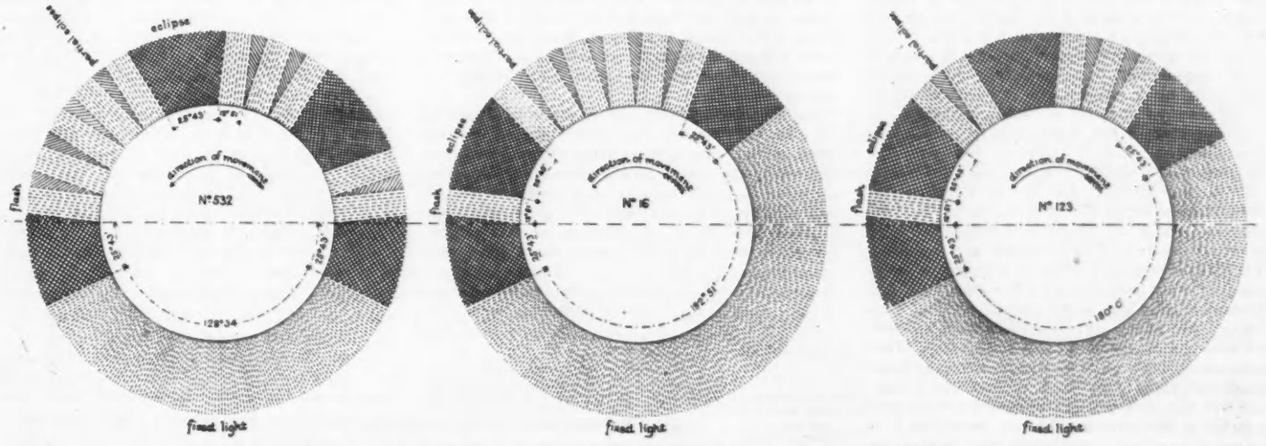
In giving signals in this way certain precautions must be observed. 1. The flashes in each figure of a group must succeed each other so quickly as not to cause too great a nervous strain in watching from one to the next. 2. The interval between the figures must be clearly defined. 3. There must not be so many flashes in any one figure of the characteristic as to run the risk of losing the count. 4. The total number of flashes in any one characteristic must not be too great. 5. The same figure must not be repeated in the same characteristic.

To meet the first condition the flashes of a figure may be about 2 seconds apart. For the second condition a partial eclipse of about 4 or 5 seconds is given. For the third condition the number of flashes in any one figure is limited to six; consequently no combination is permissible in which the figure 7, 8 or 9 appears. For the fourth condition the total number of flashes in a characteristic is limited to ten. Such a combination as 534, 632, 245, &c., is impossible. If more than ten flashes be apparently counted some error has certainly been made. The fifth condition is necessary to prevent confusion. If any figure be repeated, apparently, a mistake has been made in the count. All such numbers as 226 (2 in the tens and hundreds places), 151 (1 in the units and hundreds), 433 (3 in the units and tens) are inadmissible. With the sharp brilliancy of the flash there should be no difficulty in keeping count of the figures and hence of the characteristic.

There must, of course, be some point from which the count is to begin. This point is given by a period of fixed light which covers at least one-third of the horizon. This period of fixed white light is followed by a total eclipse of some seconds' duration, after which the characteristic is given. A second eclipse of like length announces the end of the characteristic.

Capt. MAHAN then discusses the adaptation of this system to the establishment as it exists to-day, and shows that there should be 16 additional lights to fill some breaks in the continuous belt which the Board seeks to establish. He finds that there could be 5 signals of one group, 28 signals of two groups and 60 signals of three groups, these groups being represented by characteristics like 2, 3, 4; 31, 45, 27 and 123, 235, 514, for examples. This gives 93 signals in all, or amply sufficient to give a separate characteristic to each light on the Atlantic coast, and some to spare. A fog signal at any station should have the same characteristics as the light, and if the tower is to be used as a day mark it might be painted in bands to represent the group of flashes.

The plan does not apply to in-shore lights, because there are too many to make the system continuous, though it could be applied to individual localities, like Long Island Sound, Delaware and Chesapeake bays, &c. But as red has been adopted as a characteristic of in-shore lights, one group of each light characteristic should be red. The sketches given show the three numbers—532, 16, 123.



DIAGRAMS SHOWING CAPT. MAHAN'S PROPOSED METHOD OF SIGNALING LIGHTHOUSE NUMBERS.

The Squantum-Moon-Island Section of the Boston Improved Sewerage Works.

The sewage of Boston, under the plans executed by the Improved Sewerage Commission, is led under Dorchester Bay through a tunnel, about 7,000 ft. long, and rises above the water surface at Squantum Head; from thence it is taken about 4,000 ft. on an embankment across shallow water to Moon Island, the point of discharge. The Squantum-Moon Island section has given trouble from the start of the new works and is still settling. Borings, taken about 1876, indicated an apparently solid bed of gravel extending between the Head and the Island, and a masonry sewer on an embankment was originally designed for this portion of the outlet. But shortly after the work commenced more careful borings showed that the gravel bed was only from 2 to 8 ft. thick, and that this was underlaid with mud from a few feet to 40 ft. deep.

It was then decided to build the embankment and allow it to find a solid base in time, and to carry the sewage meanwhile in a temporary wooden conduit. This embankment was made 20 ft. wide at top and about 25 ft. high on the average and 120 ft. wide at the base. Five iron rods attached to iron plates 2 ft. square were embedded in this embankment for the purpose of studying the rate and manner of settlement, and for nine years these rods have been watched. Up to date the total settlement is found to be 17.42 ft., and from the observed rate of settlement, the engineer in charge of the work, Mr. H. H. CARTER, believes that the maximum will be reached at 17.74 ft., consequently there yet remains a settlement of 0.32 ft., or about 4 ins. It will take, he says, until 1898 to reach this final level.

The original embankment was protected to a point 6 ft. above mean high water by ballast and rip-rap, 20,000 cu. yds. of the former and 54,000 cu. yds. of the latter having been used in the first construction. The temporary flume was a wooden box, 6 ft. square, resting on bents of 3 piles, 10 ft. between bents. The box was made of grooved Canadian white pine, with square frames of spruce timber at 3 ft. intervals. This flume cost about $10 per lin. ft.

The U. S. Bureau of Yards and Docks.

Commodore N. H. FARQUHAR, Chief of the Bureau of Yards and Docks, in his last annual report to the Secretary of the Navy, says that the value of buildings, dock and other improvements pertaining to this bureau, and not including real estate, is now valued at nearly $36,000,000. For the maintenance and repairs on these establishments the bureau asks for $1,000,000 for the next fiscal year.

There are in all 14 navy yards and stations, covering 2,700 acres of ground, with 439 workshops, store and ship houses, 7.18 miles of wharf line, 10 dry-docks, 19 marine railways and launching ways, and beside these many offices, miles of railway track, and water, gas and steam plants. But out of the 10 dry docks mentioned only two, the stone dock at Mare Island, Cal., and the timber dry dock now building at Port Royal, S. C., will admit the largest battle-ships at their maximum draft. The Chief therefore recommends that docks of sufficient capacity be built without delay at New York, Philadelphia and Norfolk. The new navy now built and under construction demands more wharf room, more docks, better facilities of handling coal and appliances for handling heavy armor and guns. The further recommendation that the staff of civil engineers in the navy be increased, to meet the demand for their services here outlined, is commented upon elsewhere.

The Steel Skeleton Type of High Buildings.

BY CORYDON T. PURDY, C. E.

II.

COLUMN CONSTRUCTION AND STEEL BRACING.

A riveted steel column made up of 4 Z bars, a web plate, and with or without cover plates, commonly known as the Z bar column, is the one mostly used in Chicago. Plates and angles, latticed, are also used considerably, and the Phœnix column, the Keystone octagonal column, latticed channels, and a new section made of bent beams, are used occasionally. Fig. 1 shows sections of these columns.

The relative strength of these different kinds of columns is, of course, a constant question in these days, as it has been in others, and especially so in unprofessional circles. However, when the ratio of the radius of gyration to the length of the column is as small as it usually is in building construction, rarely over 70 radii, the difference in the strength of different sections tends to disappear, and the question of relative strength is of less consequence. Any of these sections in an ordinary building column will carry the load safely, with the unit strains ordinarily used, if the column is well made and the loads are symmetrically applied, but the great trouble is that either of these conditions may be wanting in actual practice.

The following points bearing on other conditions of the problem are really more important: 1. Cost. 2. Availability. 3. The character of the workmanship of the finished column. 4. Means of applying loads as closely as possible to the axis of the column. 5. The convenience for connections. 6. Convenience for providing against eccentric loading. 7. The relation of size to section of small columns. 8. Relation of section to fire proofing.

Points 1, 2 and 3 are most important to the builder and often govern in the selection of a column; points 4, 5, 6 and 7 are for the engineer to deal with, and point 8 is the one that interests the architect most directly.

The cost of columns containing beams or channels must be based on pool prices for those sections; columns containing latticed bars, fillers or gusset plates are handicapped on the side of cost to the extent of the weight of this material. Beyond these and possibly a few other such general considerations the question of cost is purely a commercial one. Patent columns, or columns that can be manufactured in only one shop, are in general not as available as those that can be made anywhere.

The character of the workmanship of columns varies in different shops. It varies, too, with the different sections of columns, because of the way in which the material has to be punched and riveted in order to put the parts together. In these three issues the Z bar column generally has the advantage on account of the latticed bars required, and this advantage is increasingly great in small columns. The Z bar column is, however, at a disadvantage in the last point named, that of fireproofing. Any of the other sections named will fireproof more compactly than the Z bar column. This disadvantage, however, is really an advantage from an engineer's point of view. A column 6 ins. in diameter will not, of course, carry some loads as well as another of the same weight per lineal foot having twice the diameter, and sometimes as many as 6 beams must connect to a column at one level. In such cases it is almost impossible to make a good connection on a small column, and if the load is applied from a 20-in. beam, as is often the case, the small column seems out of proportion to the beam, and the means for connecting it to the larger column are certainly very much better than to the smaller.

This question of connections is becoming constantly a more serious one. When there are only, at the most, 4 beams to a column, all the same height, and on opposite sides, a satisfactory detail can be made for almost any column, but when the designs of the architect necessitate the arrangement of beams irregularly, both as to position in plan and as to height, it becomes very important that the section of the column itself should afford as much opportunity as possible for the connection of plates and angles. The ways in which these can be riveted to Z bar columns are almost innumerable. It seems as if no section could be devised that could give more scope to the genius of the designer than this, and the advantage is greater in columns without plates, that is, the smaller columns, where almost always the connections are hardest to make. Channel columns and columns made of plates and angles are also very convenient for detailing. Indeed, in this particular they rank with the Z bar column, but the other sections are considerably handicapped in this particular.

The fourth point named in the above schedule, the axial application of loads, deserves more than a passing notice. The engineers that are doing the best designing of this kind of construction are giving a good deal of attention to the equal distribution of loads about the axis of the column and of bringing the loads as near to the center as possible. Every gain in this direction adds directly to the efficiency of the column, and one in which a one-sided load can be applied close to the axis is good for a much greater unit strain than another where the application must be made farther from the center. In this particular, again, the Z bar column has an advantage over any form of closed column, and this is so even when cover plates are used. For the column may almost always be turned so that the end of the beam carrying an eccentric load can be introduced between the flanges of the bars. When small columns carry heavy beams, as is usually the case at the top of a building, this feature of the problem is most important. The Z bar column is open on all four sides so that every load may be actually taken between the flanges of the column. The same end may be gained, to a considerable extent, with a column made of channels, latticed, or one made of angles and plates, but the other sections are unfavorable.

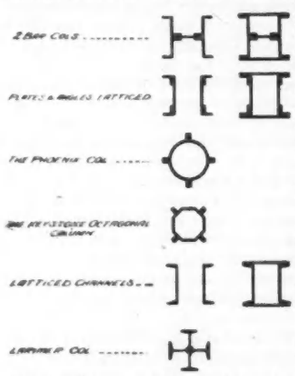


Fig. 1.—Sections of Steel Columns used in Building Construction.

The Z bar column, by the addition of plates or bars or by changing the dimensions of the web plate, may be arranged so that the radius of gyration shall be greater or less in either direction across the section. If all the loads which come on the column are applied on one side it is a great advantage to have the radius of gyration in that column greater on the line of the load, on exactly the same theory that girders are built deeper than they are wide. Scarcely any great buildings are erected where some of the columns are not loaded in this way. And in some of our Chicago buildings this matter is thoroughly studied with a view to obtaining the utmost efficiency of the metal used. It may be readily seen by the examination of these sections that some of them by their very shape are entirely disqualified for the application of this principle in column designing. And in this way again, from an engineer's standpoint, they are at a disadvantage.

On account of all these considerations the Z bar column seems most admirably adapted to building construction. It has also an additional advantage in having only two rows of rivets and those near the center of the column, for it is reasonable to suppose that holes punched in the other part of the column must tend to weaken the member even when the riveting has been well done, and this is most important in small columns, where the ratio of the radius of gyration to the length of the column is generally greatest, and where by every possible means we want to get the greatest efficiency of the metal. The Z bar column has been used in the Temple, the Fair, Ashland Block, Venetian building, the Rand-McNally, the Caxton, Pontiac, Monadnock, the Northern Hotel and other smaller buildings. The columns in the Masonic Temple are made of plates and angles, the smaller ones latticed. The Cook County Abstract Building is being built with Phœnix columns.

The greatest mistakes in the designs of building construction are undoubtedly due to errors in the calculation of loads. With this in mind a constantly increasing care is being exercised by all concerned in the calculations of column loads. These may be classed as dead loads, live loads, wind loads and eccentric loads. All materials actually used in the construction of a building are rated as dead loads; water in tanks, elevator machinery and anything else not actually a part of the building, but making a definite and permanent load in the building, may also be classed as dead loads. Office furniture, machinery that can be moved or changed, stocks of goods, movables of every variety, and people are usually classed as live loads. The vertical components of all wind forces are the wind loads. One-sided loads, of whatever nature, are termed eccentric, and in our best practice all these different classes of loads have special treatment and are kept distinct.

We give in Table I. below a schedule of the loads in one column in the Venetian Building, taken directly from the notes in the writer's office.

In this building the dead weight on the office floors is taken as 100 lbs. per sq. ft. This includes the weight of the arch, the concrete, wooden floors, plaster ceilings, steel beams and partitions—the last two items being actually calculated and then rated so much per square foot of floor area. It is necessary in office buildings to treat partitions in this way because they are being constantly changed. The live load on these floors has been taken at 35 lbs. per sq. ft. On the second, third and fourth floors it is taken at 60 lbs., and on the first floor at 80 lbs. The whole of the dead load and about one half of the live load is carried into the columns. The best practice in Chicago in regard to floor loads is to calculate all the beams for the total dead and live loads, while the girders (the word girder in building work is generally used to signify a beam that carries beams) are required to carry the dead load and about 80% of the live load, and the columns the dead load and half, or even less, of the live load. This practice is based on the theory that it is quite possible the beams will some time have to carry all the live load, while the chances are increasingly less that the girders and the columns will ever be required to do so.

The floor loads shown in the above schedule are the product of the floor areas tributary to the columns and the rates per square foot as given above.

TABLE I. LOAD SCHEDULE FOR ONE COLUMN OF THE VENETIAN BUILDING. *Illustrating Method of Computing Strains.*

NAME OF COL.	Roof.	Attic.	12th.	11th.	10th.	9th.	8th.	7th.	6th.	5th.	4th.	3rd.	2nd.	1st.	Basement.	Total.
Load from col. above		4,620	31,440	104,990	142,350	179,710	217,070	254,490	372,030	409,670	447,370	485,310	524,920	567,740	609,790	
Floor dead load	4,620	13,860	10,310	10,310	10,310	10,310	10,310	10,310	10,310	10,310	10,310	10,310	10,310	10,310	10,310	152,510
Floor live load			1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	3,100	3,100	3,100	6,200	29,450
Spandrel load		12,960	15,070	24,700	24,700	24,700	24,700	24,700	24,700	24,700	24,700	24,700	27,610	26,710	25,100	329,780
Elevator load			46,000					80,000								126,000
Estimated weight of col.			620	800	800	800	860	980	1,080	1,140	1,330	1,500	1,770	1,930	2,550	16,210
Total	4,620	31,440	104,990	142 350	179,710	217,070	254,490	372,030	409 670	447,370	485,310	524,920	567,740	609,790	653,950	653,950
Wind Loads.																
Concentric			2,440	10,973	22,975	39,739	61,059	86,937	117,168	153,143	193,460	237,533	288,619	341,047	401,389	
Excentric		2,440	8,533	12,002	16,764	21,320	25,878	30,231	35,975	40.317	44,073	51,086	52,428	60,342	0	
Total		2,440	10,973	22.975	39,739	61,059	86,937	117,168	153,143	193,460	237,533	288,619	341,047	401,389	401,389	

It is in the determination of these areas that mistakes very often occur, and a great deal of care should be used in determining them. If the arrangement of the beams is complicated the area tributary to the column may be found upon examination quite different from what it first appears to be.

(To be concluded.)

The Day System of Elevated Railway Construction.

BY T. G. GRIBBLE, A. M. I. C. E.

The Day system of bridge construction is a new departure upon the suspension principle. It cannot be rightly termed a suspension bridge because the vertical stresses from a moving load are resolved under certain conditions into oblique forces through the bracing, after the manner of a frame. Neither is it a framed suspension bridge, which is a hybrid structure having its chord strings varying under certain conditions from zero at the center to a maximum at the piers, and its bracing acting alternately as struts and ties. Such a structure would be more properly termed a suspended truss. Its weight is greatly in excess of the suspension bridge and it lacks the symmetry. The Day tension frame is in outward appearance a suspension bridge of enhanced symmetry having the straight lines of the roadway relieved by the curve of the lower cable, but the appearance is only an adjunct of some very important mechanical advantages.

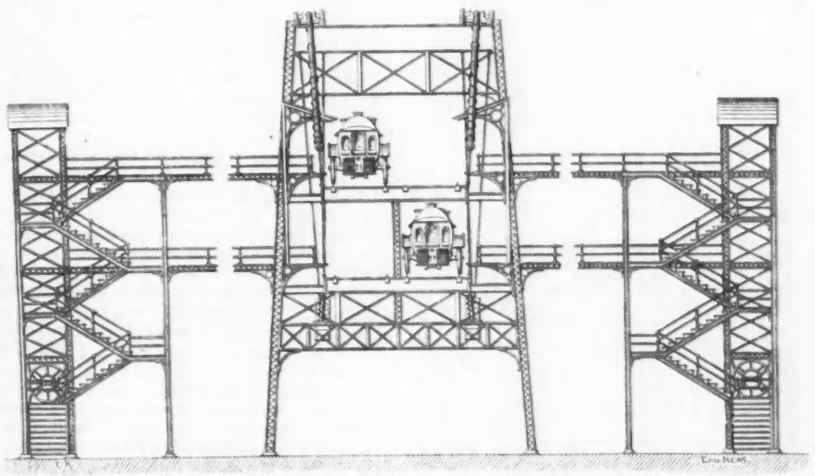


FIG. 1.—DOUBLE DECKED ELEVATED RAILWAY ON THE DAY SYSTEM; CROSS SECTION AT STATION.

The tension frame has for its object the sustaining of a varying suspended load, without deformation, by replacing the undulations made upon a suspension chord during transition from one curve of equilibrium to another by *tensile stresses alone*. These stresses are those which take the place of the bending movement produced in a stiff inverted arch when the curve of equilibrium passes outside the section of the arch.

The essential feature of the invention is the application of a lower upturned cable to distribute the stresses tending to deformation between the upper and lower cables acting against one another. An equally important point is the possibility of dividing the space between the cables into panels in which a pair of antagonistic diagonal braces act alternately by tension only, conveying the strain from the upper to the lower cable, no single panel being able to deform without being resisted by one or the other of the braces. The lower cable of itself resists deformation on account of its shorter length, and the panels individually resist deformation because one diagonal would always be lengthened before deforming action could take place. Our nursery reminiscences of the "cat's cradle" illustrate the primary principle of the tension frame.

It is obvious that the so-called elasticity of suspended structures is due entirely to deformation. There is no greater elasticity in steel under tensile than under compressive stress. If a suspended wire could be anchored down continuously, it would be as rigid vertically as a girder.

The deformations of variable loads are not so serious to ordinary suspension bridges as the rapidly augmented undulation produced by the vertical compound of a violent wind-force. Partial and local remedies, such as independent downward ties, greatly diminish these defects, but the effect of an under cable is to tie down the whole roadway continuously to points of attachment, comparatively close to the base of the pier. The combination of deep stiffening trusses, with ordinary suspension bridges, also greatly improves their stability, although such trusses do not prevent the rods from assuming an oblique position above them. Since, however, the efficiency of such remedies is such as to render the application of the suspension principle practicable for heavy rolling loads, it is reasonable to expect a much wider application of the same principle by means of the tension frame.

Another feature of the tension frame is that when one span is loaded more than another the balance is taken up by the under cable of the adjacent spans, and if the spans themselves are equal the reactions of the piers remain vertical. The advantage of the systems for elevated railways, one of which is to be constructed immediately from the Rock Island Railway to the World's Fair, is in its cheapness, freedom from obstruction and general artistic appearance.

The longer the span the greater is the comparative economy of the suspension principle. There will be no need of rows of columns all along the streets, the spans will be from block to block with towers spanning the cross streets and leaving headway for vehicles. If necessary, the structure can surmount the houses, the only extra cost being in the towers. A rail is to be used which will deaden vibration in a novel manner, and of great stiffness to resist deflection. The cars are also of original design, tubular in cross section, having outside wheels revolving on fixed axles. The motive power is to be electricity.

FIG. 2. DOUBLE DECKED ELEVATED RAILWAY ON THE DAY SYSTEM WITH VERTICAL BRACING AND STIFFENING TRUSS.

The two principal reasons which have invested this scheme with so much interest in Chicago are: 1, the position of that city with regard to rapid transit; 2, the situation as to trunk line terminals. The cable roads are carrying all the people they can and killing not a few of them. The switching on trunk line terminals also has its bearing upon the death rate and is a great eyesore to the citizens. To tunnel under the city, except at great depths, would be to endanger the tall buildings, and to go over would be to purchase real estate at fabulous prices. The constant outcry in the daily press for something to be done is met by the difficulty of how to do it.

With regard to the comparative cost of the tension frame principle, and that of arches or girders, the extra weight over and above that of the simple suspension bridge is that of the lower cable less that of the independent downward ties ordinarily employed. The comparative weights of bridges of different types is given by Prof. FLEEMING JENKIN, exclusive of roadway, which is common to all, in a paper read before the Royal Scottish Society of Arts, from which the following extract will be sufficient:

SPAN IN FEET.	Weight in Tons.			
	Suspens'n bridge.	Arch.	Bowstring girder.	Lattice girder.
200	19	41	70	83
400	83	194	375	475
600	200	530	1,200	2,220

The estimated cost of a mile of elevated railway upon the Day system, is $231,000, as against $500,000 for the ordinary type of short span elevated railways. The type span for the Day construction is 400 ft., but it would vary according to the length of the blocks. Comparing a 400-ft. tension frame with a 400-ft. girder from the above table, and adding weight of roadway, the figures are as follows:

	Tons.
Girder—Main members	475
Roadway	140
	615
Tension Frame—Upper cable and bracing	83
Under cable	45
Roadway	140
	268

From which we see that the tension frame complete is about 43% of the girder. The tension frame is furthermore adapted to surmount high buildings with less cost in pier construction by reason of its lighter weight, and to span greater gaps than would be practicable either by the arch or girder.

The Origin and Early History of the Camden & Amboy Railway.

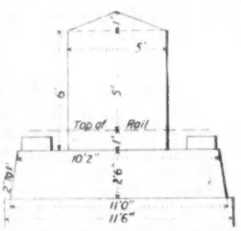
On Nov. 12 a monument was dedicated by the Pennsylvania Ry. Co., at Bordentown, N. J., with fitting ceremony, to commemorate the 60th anniversary of the first movement of trains by steam upon a railway in New Jersey. We show herewith a drawing of the monument erected, which will be seen to have been made up chiefly of old historical material. On this occasion Mr. J. ELFRETH WATKINS, C. E., Curator of the section of Transportation and Engineering of the U. S. National Museum, at Washington, D. C., delivered an address upon the origin and history of the Camden & Amboy Railway, from which we make the following abstract:

From an historical point of view as early as 1675 the Council adopted regulations regarding the location of wagon roads, and in 1682 two roads were opened across the province between New York and Philadelphia. In 1683 the route via Perth Amboy to New York was opened. In 1707 the Assembly complained to Lord CORNBURY "that patents had been granted to individuals to transport goods on the road from Amboy to Burlington for a number of years, to the exclusion of others." This was the first monopoly and was denounced as "destructive to that freedom which trade and commerce ought to have." The Governor defended the monopolist DELLAMAN, and showed that by reason of this exclusive right he was enabled to afford better transportation for goods than was ever known before, and which "in all probability never would have been" without this right.

In 1751 JOSEPH BORDEN ran a "stage boat" from the Crooked-billet wharf, in Philadelphia, to Bordentown, up the Delaware River. From Bordentown a stage-wagon conveyed goods and passengers to Perth Amboy, and thence they were carried to New York in another "well-fitted stage-boat." The traveler left Philadelphia every Tuesday and arrived in New

York on Friday evening, which, "'Tis believed, is 30 or 40 hours, the fastest time yet made," according to the quaint advertisement of the time. Little was done to improve upon this method of travel for many years, saving that other routes were opened and the time was gradually reduced. About 1800, turnpikes attracted the attention of the interior portion of the state and the first road of this character was chartered March 9, 1801, from Elizabethtown through Morristown to the Delaware opposite Milford. Before Feb. 1, 1828, 54 turnpike companies had been chartered by the state and 550 miles were built, mostly made with a superstructure of gravel.

JOHN STEVENS (1749-1838), of Hoboken, issued his remarkable pamphlet on Railways vs. Canals in 1812, and he with his sons ROBERT, EDWIN and JOHN were the projectors and constructors of the Camden & Amboy Ry. In 1815 he received a charter from the State of New Jersey to build a railway connecting New York and Philadelphia, the first railway charter granted in the United States. In 1823, in conjunction with HORACE BINNEY and STEPHEN GIRARD, he obtained a charter from Pennsylvania for a railway from Philadelphia to Lancaster on the line of the present Pennsylvania railway. In 1812 JOHN STEVENS, in connection with his son ROBERT, had made steamboat navigation on the Delaware a commercial success, and he was anxious to put to the test his theories on railway transportation. He obtained the charters before mentioned, but his schemes were regarded as wild and visionary until the English experiments in 1825 caused people to recognize the needs of railways. In 1827 passengers left New York at 12 noon, arriving at Philadelphia early next morning, and they now sought to shorten this time.

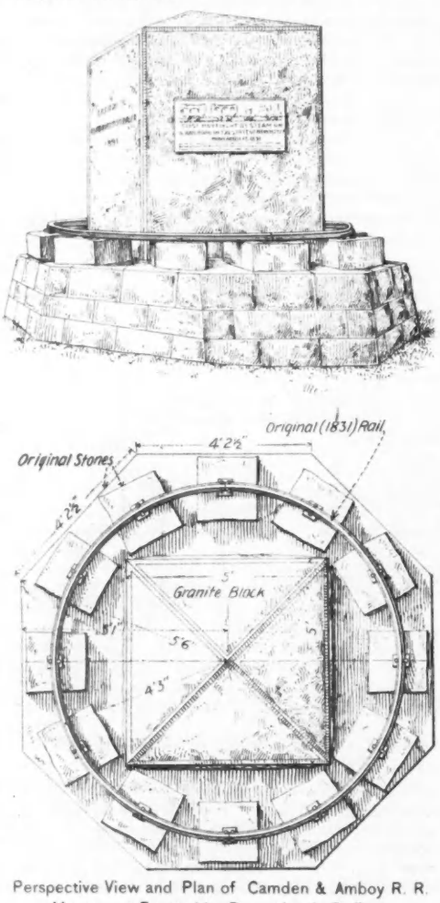


Outline Section of Monument Showing Principal Dimensions.

On Jan. 14, 1828, the first public railway meeting was held at Mount Holly by citizens interested in the construction of a railway from Camden to South Amboy. During 1829 other meetings were held at principal towns in the state, and numerous petitions and memorials for the incorporation of a railway company were presented to the legislature. On July 4, 1828, the corner-stone of the Baltimore & Ohio Railway was laid by CHARLES CARROLL, of Carrollton, at Baltimore, and at that time two or three short tramways had been laid from quarries or collieries to adjacent navigable waters. These were in Delaware, from the Leiperville quarry to the Delaware River; in Virginia, on the James; in Massachusetts, near Neponset, and in Pennsylvania at Mauch Chunk. Early in 1829, the "Stourbridge Lion," the first locomotive that turned a wheel on a railway built for traffic on the Western Continent, arrived from England and made its first trip under HORATIO ALLEN.

But the advocates of canals opposed the growing favor for railways, and fought the proposed New Jersey railway, until a compromise was arrived at in 1830 in the legislature. On Feb. 4, 1830, a charter was granted to the Camden & Amboy Railway & Transportation Co., and another on the same day to the Delaware & Raritan Canal Co. The capital stock of the railway was $1,000,000, with power to raise this to $1,500,000, and an organization was effected at Camden, N. J., on April 28, 1830. The first officers were ROBERT L. STEVENS, President; EDWIN A. STEVENS, Treasurer; JEREMIAH H. SLOAN, Secretary. ROBERT L. STEVENS was also appointed Chief Engineer at a salary of $6,000, and the early surveys of the line were made under the direction of Major JOHN WILSON, between the spring of 1830 and Oct. 2 of the same year. The surveying parties were in charge of Lieut. WILLIAM COOK and JOHN EDGAR THOMSON, afterward president of the Pennsylvania Railway Co. The surveys were so made that as large a part of the route as possible would be a water route, as it was then, and long after, believed that traveling by steamboats would always be more popular than traveling overland, and that railways would only be subsidiary to the water routes. Grading was commenced at Bordentown on Dec. 4, 1830, and the first cars, drawn by two horses, were run from Bordentown to Hightstown, Sept. 19, 1832. On Dec. 17 of the same year the first passengers were taken from Bordentown to South Amboy, and on Jan. 24, 1833, the first freight cars were put on the road—three cars drawn by one horse each, with 6,000 to 7,000 lbs. on each car. The line from Bordentown to Camden was opened to traffic in January, 1834.

Mr. WATKINS treats at length of the inception of the Delaware & Raritan Canal and the rivalry of the two companies, which finally ended in the consolidation of their interests by "The Marriage Act," of Feb. 15, 1831.



Perspective View and Plan of Camden & Amboy R. R. Monument Erected by Pennsylvania R. R. at Bordentown, N. J.

In October, 1830, ROBERT L. STEVENS sailed for England to order a locomotive and rails for the new road. Mr. STEVENS advocated the use of an all-iron rail, instead of the strap form adopted on the short American tramways, and during his voyage to Liverpool he designed the American rail and hook-headed spike. To avoid the expensive chair used with the Berkenshaw rail he widened out the base of a T-rail at intervals and to hold it down to the ties he devised the hook-headed spike, and also the "iron tongue," which has developed into the fish plate, and the rivets, now replaced by nuts and bolts, to make the joint. Owing to the difficulties of rolling the widening of the base of the rail at intervals was abandoned and the base made 3 ins. wide throughout. After many difficulties surmounted at the iron works of Sir JOHN GUEST, at Dowlais, Wales, and the deposit of a sum of money by Mr. STEVENS to guarantee the expense of repairs to the rolling mill in case of damage, the new rails were finally rolled. At first they came from the rolls "as crooked as snakes," but the mill men finally acquired the art of straightening them as they cooled. The first shipment of 550 bars, 18 ft. long, 36 lbs. to the yard, arrived in Philadelphia on May 16, 1831, and before the summer of 1832 thirty miles of this rail had been laid. While 36 lbs. was at first adopted as the standard weight per yard, this was almost immediately increased to 40 and 42 lbs., and rolled in lengths of 16 ft. The rail was then 3⅛ ins. high, 2⅛ ins. wide on head and 3½ ins. wide on base. The price paid in England was £8 per ton, with an import duty added of $1.85. The first piece of track was laid in August, 1831, at the point now marked by the Bordentown monument. This first track was laid on stone blocks 2 ft. square by 10 to 13 ins. deep.

The joints were made by an "iron tongue," 5 ins. long by 2 ins. wide by ⅝ in. thick, riveted to the stem of each rail, with an oblong hole in each stem to allow for contraction and expansion. The ends of the rails were designed to rest upon plates of wrought or cast iron. The first spikes were "6 ins. long with hooked heads," and these were undoubtedly the first railway spikes of the modern type ever manufactured. Mr. STEVENS neglected to patent either his rail or spike, and the honor is claimed by others; but the evidence of late years fully establishes the fact that he was the originator of these important features of the American system of railways.

The "John Bull" locomotive was shipped from Newcastle-on-Tyne, by the order of Mr. STEVENS, in June, 1831, and arrived in Philadelphia in August of that year. It was modeled after the "Planet," built by Stephenson & Co., and tested Dec. 4, 1830, Mr. STEVENS being present. This locomotive was tested at Bordentown, in August, with a tender improvised from a four-wheel flat car carrying a large whiskey-cask. On Nov. 12, 1831, an official trial took place before members of the Legislature and State officials, and this was the event celebrated on Nov. 12, 1892.

The first pilot, says Mr. WATKINS, was planned, in 1832, by ROBERT L. STEVENS, and applied to the "John Bull," as seen on the familiar engravings of that locomotive. MATTHIAS BALDWIN made a small working model of this celebrated engine for exhibition at Peale's Museum in Philadelphia, and in 1832 he was called upon to construct the "Ironsides," the first locomotive used on the Philadelphia & Germantown Ry. The success of this engine laid the foundation of the great Baldwin Locomotive Works.

The first Standard American track was laid in Dec. 1832 in "the deep cut," at South Amboy, and owned its origin to the failure of the stone contractors to deliver blocks rapidly enough. Mr. Stevens ordered hewn wooden cross-ties to be laid temporarily and the rails spiked to these. A number of these ties were laid on the sharpest curves in the cut, and they showed such satisfactory properties that they were permitted to remain, and the stone blocks already in the track were replaced by these ties as rapidly as practicable.

The conclusion of Mr. WATKINS' most interesting and valuable address relates to the growth of the railway system in New Jersey, and its methods of management. While the record is a most remarkable one, and shows the successive stages through which this pioneer line has passed to the present day, space forbids further detail.

THE BROOKLYN BRIDGE CAISSON SUIT is now before a commission of adjudication in New York. This is the long pending suit of JOHN DUBOIS, of DuBois, Clearfield Co., Pa., who claims that his patent for caissons was infringed in the construction of the tower foundations of the Brooklyn bridge. He commenced his suit in 1884, and it was then fought to a standstill. But last year he secured the passage of a bill at Albany permitting him to reopen the case and directing the cities of New York and Brooklyn to appoint a commissioner each to act with a third appointed by DUBOIS; if the mayors of the two cities approve the report of this commission damages are to be paid, if awarded. Mr. S. V. WHITE represents Brooklyn, Judge CLANCY is for New York and Judge GILBERT for DUBOIS. A claim of $1,500,000 is made on the ground that the patent saved that much to the bridge builders. DUBOIS patented a caisson in 1862, which the defense claim and prove by and books documents is over 100 years old and was frequently used before the date of issue of the DUBOIS patent. The evidence shows quite clearly that the Patent Office was remiss in granting a patent for an antique method of constructing, which was substantially the same as that adopted in building the Westminster bridge in London in 1738. The case of the claimant will not be decided for some time yet.

Disputed Points in Railway Bridge Designing.

At the last meeting of the American Society of Civil Engineers, as reported in our last issue, Mr. J. A. L. WADDELL read a paper on "Some Disputed Points of Bridge Designing," which, as stated, was too long for us to attempt to abstract in that issue, but which was throughout a suggestive and valuable paper, of which we now give the following very full abstract. Mr. WADDELL began by saying that the object of the paper is to induce discussion on the still unsettled points of bridge designing, with a view to more general agreement in opinions and practice; which latter, of course, cannot be attained at once, if ever, but may be continually approached to. Great progress in this direction has already been made within the past few years. For instance, plate girders are now standard practice up to 90 to 100-ft. spans and double intersection trusses are looked on with disfavor. Nevertheless, some engineers still employ them, as also objectionable details like pony truss pin connected bridges and suspended floor beams with adjustable hangers.

The author then groups the disputed points as follows, discussing each in order: *A*, Live Loads; *B*, Wind Pressure; *C*, Styles and Proportions of Bridges; *D*, Intensities of Working Stresses; *E*, Combined Stresses; *F*, Plate Girder Proportioning; *G*, General Details of Construction. Under class *A* are considered, first, Uniform Loads *vs.* Engine Concentrations, and second, The Proper Live Loads for Modern Bridge Specifications.

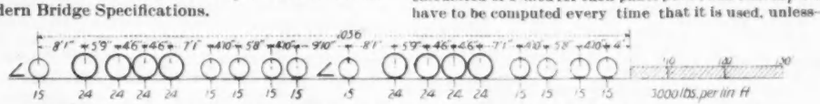


FIG 3.—LOAD DIAGRAM FOR "CLASS A" LOCOMOTIVES; COOPER'S SPECIFICATIONS.
(Loads in Thousands of Pounds.)

UNIFORM LOADS VS. ENGINE CONCENTRATIONS.

Several years ago two or three American engineers evolved independently the theory of engine concentrations for the finding of stresses in bridge members. No doubt these gentlemen at that time considered, and perhaps even yet think, that they were conferring a great boon upon the engineering profession; but instead of this they were really hampering it with a burden grievous to be borne. That such is the case every professional bridge computer, whose business it is day after day, month after month and year after year to calculate the stresses in bridge trusses, will readily and sadly acknowledge. The plea that this method is more accurate than the old one involving uniform loads either with or without engine excesses at panel points, and that the calculations of stresses made thereby are just as simple and easy, is a fallacy. Of course for any particular engine and train, the former method will give slightly more accurate results than will the latter. But there are never two trains alike in respect to amount and distribution of load, for the engines on any railway vary greatly in weight and wheel distribution; and the weights on the cars are extremely irregular. It must be acknowledged, therefore, that all assumed loads for computing stresses in bridges are merely typical; consequently when assuming a typical load, would it not be well to adopt one that will reduce the labor of the computer to a minimum, provided, of course, that it will give just as correct results as would one consisting of engine concentrations followed by a uniform car load? That such is practicable the writer will show presently.

Now as to simplicity and ease of calculation: Even in the most favorable case, viz., that where the chords are parallel, the panels of equal length, the structure square and the span comparatively short, it will take fully twice as much time to compute the stresses by concentrations as it will to find them by the old method. But when the span is long, the top chord broken, the panel lengths unequal or the structure on a skew, the amount of labor involved by the concentration method is simply discouraging. How many engineers are there who make or have made a practice of computing the exact stresses in Whipple trusses by engine concentrations?

Not content with burdening computers to the extent of at least doubling their labor by enforced calculations involving engine concentrations, certain writers of bridge specifications have "added insult to injury" by specifying that each structure must be designed throughout for two and even three fundamentally different live loads, each involving a peculiar type of engine.

Let us for an instant consider the designing in competition of either a drawspan or a cantilever bridge according to one of these modern specifications and see what work there is involved. To begin with, there will be, say, six competing bridge companies, each employing for this work on an average two computers. Now, although these gentlemen may be firmly convinced that the requirements of the specifications in respect to live load are mere humbug and nonsense, and that they could obtain practically correct results with one-tenth of the amount of figuring by assuming equivalent uniformly distributed loads, still they dare not shorten their work in this way for fear that some captious critic in checking their papers might find a variation in the stresses of 1 or 2%; consequently all twelve set to with more or less ill grace to calculate the exact maximum and sometimes also the exact minimum stress for each member of the bridge. Now, it was discovered not long ago that when the top chord is inclined to the horizontal the maximum stresses do not occur with the same position of wheel loads as they would were the top chord horizontal. Hence it was sometimes necessary to make for each truss member three or four trials, each involving considerable figuring, before ascertaining the exact position of wheel load that would give absolutely the greatest stress.

Since then, however, the true theory of maximum stresses for engine concentrations in cases of inclined top chords has been worked up by one of our clever mathematicians, consequently it will no longer be necessary to use the "cut and try" method, but merely to employ the following simple little equation:

$$\text{Shear} = \left[\frac{M_r d}{l} - \frac{M_x (d + np)}{p}\right] \frac{1}{d + (n+1)\,p}$$

after having found, by trial, which wheel load should be over the panel point under consideration, by means of another pretty little equation, viz.:

$$\frac{P_n + wy_n}{N} > P_x \frac{d + np}{d}$$

It must be borne in mind, too, that d has to be either calculated or scaled for each panel point, and that M_r will have to be computed every time that it is used, unless—which is highly improbable—a wheel load will come directly over the end of the span.

After having worked out all the maximum stresses by this method, our twelve computers have accomplished only one-third of their task; for they must twice more attack the same problem, but with different wheel concentrations.

After finding all of the live load stresses in the manner called for by the specifications, the remainder of the computations for the six designs will be of a comparatively simple character; so let us suppose that all the papers of the six competing companies have been handed in. One company only can secure the contract; consequently the work of at least ten men has been entirely wasted; and in fact there is often a strong probability of the work of all twelve being useless or at least unrewarded; for some other bridge company may have "an inside track" and build the bridge upon the set of papers which appears to be most satisfactory to the parties purchasing; or said parties may conclude that the proposed bridge is too expensive, and that they will build either a combination or a wooden structure. How much better off all six companies would have been had the calculations been made for an equivalent uniformly distributed live load, either with or without engine excesses, by the quick and elegant graphic method.

If one consider that the proper intensities of working stresses are to a great extent a matter of opinion, and that engineers often differ thereon as much as 20%, he ought to be very quickly convinced that an endeavor to obtain stresses with extreme accuracy is nothing more nor less than hair splitting. But the best possible argument that any one can advance against the use of engine diagrams in computing bridge stresses is a simple reference to Prof. EDDY'S elaborate paper, "A New Graphical Solution of the Problem: What Position a Train of Concentrated Loads must have in order to cause the Greatest Stresses in any given part of a Bridge Truss or Girder" (Trans. Am. Soc. C. E., May, 1890). Ye gods! What a mass of complicated mathematical formulas that paper contains, and all to settle such a trivial little point! It needed not such an elaborate investigation as this to attest Prof. EDDY'S great mathematical ability, consequently it seems a pity to have wasted so much valuable time. However, it may not prove to be time wasted after all, for Prof. EDDY'S paper may be the means of proving to the profession that in computing stresses by engine diagrams and proportioning parts by assumed intensities which do not provide adequately for the effect of impact, they have been "straining at a gnat and swallowing a camel."

In order to demonstrate the writer's assertion that practically exact stresses can be found by the assumption of equivalent uniformly distributed loads, let us take as a standard for comparison Mr. THEODORE COOPER'S engine diagram denominated "Class A," as shown in the accompanying Fig. 3, as it is undoubtedly the diagram that has been most widely used since calculations by means of such diagrams came into vogue.

By its use have been figured the bending moments and shears in the following tables. Those for stringers and plate girders have been computed for span lengths varying by 2½ ft. up to a length of 25 ft., by 5 ft. between the limits of 25 and 60 ft., and by 10 ft. between 60 and 100 ft. In the case of truss spans the smallest length has been taken equal to 100 ft. and the greatest equal to 300 ft., the intermediate spans varying in lenghth by 50 ft., all of which is merely for convenience. For the same reason a single panel length (25 ft.) has been adopted for all cases, and the chords have been assumed to be parallel and the trusses to be of the simple Pratt type. Although these conditions would not all be realized in modern practice, still the assumptions cannot in any way vitiate the results of the investigation.

It will be observed that there are but two cases of loading to be used in the proposed simple method of making computations, viz., equivalent uniformly distributed loads for the chords and webs of all girders and trusses, and an additional load for testing the shearing resistance of the webs of plate girders at the ends of the spans. In reality, the last load will be found to be needed only in cases of very shallow girders, consequently we may say that the proposed method for all cases of ordinary practice reduces to the use of equivalent uniformly distributed live loads.

That these equivalent loads can be used in finding the reactions or concentrations over floor beams, the writer has just ascertained while preparing a summary of the results of the calculations that were made in compiling the tables in this paper.

The rule for finding a floor beam concentration is to multiply the equivalent uniformly distributed live load per lineal foot for a span of two panel lengths by the length of one panel. If said equivalent load were determined for the midspan bending moment, the result will be mathematically correct; but if it were determined for the absolutely greatest bending moment at any part of the span, the result will give a very small error on the side of safety.

That the principle was unknown to the engineering profession only two years since, is evident from a perusal of Mr. THEODORE COOPER'S paper on "American Railroad Bridges" (Trans. Am. Soc. C. E., July, 1889), for on p. 27 he says:

> To represent the action of a train load properly by this method, we should need four different series of equivalent loads, all varying for each span. The apparent simplicity, therefore, of using equivalent uniform loads for proportioning our structures is a fallacious one; when applied to partial loads it becomes far more confusing and untrustworthy. The old method of computing strains by use of panel loads and equivalent uniform loads (and too often using only the one derived from the moments) has gradually given way to a system much simpler, more accurate, and also as easy of application.

Again referring to the table at the top of p. 26 of the same paper, drawing lines from the loads in the "Double Shear" column to the loads for twice their span lengths in the "Moment" column, and allowing for slight inaccuracies of calculation, or for the fact that the absolute maximum moments rather than moments at mid span were adopted in computing, what do we find? Not a confirmation of the mathematical theory herein given, for mathematical work needs no confirmation, but a sure proof that not one of us at that time knew the existence of the principle that will be demonstrated presently.

[Prof. A. J. DU BOIS in his discussion challenges this claim that something heretofore unknown has been discovered or enunciated in this paper, and it appears to us successfully, but modifying the claim to one that the practical application of the principle was not usually recognized, the claim has more substantial grounds to rest on, and we, therefore, give it as written.—ED.]

Referring to the quotation from Mr. COOPER'S paper, it can be concluded that that gentlemen is not only strongly in favor of the continued use of engine diagrams, but also that he is just as strongly opposed to the use of equivalent uniform loads. Consequently it is fair to presume that, after reading what precedes and follows this, he will give the matter a thorough discussion.

The following is a mathematical proof of the rule previously stated, and it is so simple that the writer is amazed that the principle was not discovered long ago:

Let P be any load, L the double panel length, x the distance from the nearer end of the span to the point of application of P, R the reaction or concentration over floor beam, and w the equivalent uniformly distributed load per lineal foot of span that will produce at the middle of the span the same bending moment as that due to P.

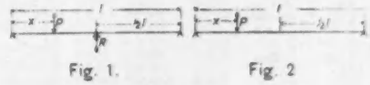


Fig. 1. Fig. 2

In Fig. 1 we have $R = \frac{2Px}{l}$, ... Eq. 1.

In Fig. 2 we have the moment at mid span $M = \frac{Px}{2} =$

Equating this to the moment at the same point caused by the equivalent uniformly distributed load we have

$$\frac{Px}{2} = \frac{1}{8} w l^2, \therefore w = \frac{4Px}{l^2}$$

Now, multiplying w by the panel length, we have

$$\frac{1}{2} wl = \frac{l}{2} \cdot \frac{4Px}{l^2} = \frac{2Px}{l}, \quad . \quad . \quad \text{Eq. 2.}$$

Comparing Eqs. 1 and 2, we have $R = \frac{1}{2} wl$.

Now, as this is true for any single load, it therefore holds good for any summation of loads, consequently the statement is proved.

PLATE GIRDER LIVE LOADS.

To the writer's assistants, Mr. A. C. STITES, Assoc. M. Am. Soc. C. E., and Mr. LEE TREADWELL, Jun. Am. Soc. C. E., is due the credit for making the numerical calculations before referred to, and upon which the treatment of this whole subject of equivalent loads vs. engine concentrations is based. These gentlemen figured independently, being some 300 miles apart, then compared results; consequently said results can be accepted as reliable.

It is not necessary to prove here that such a table as the above [shown in the first two columns of the table below. ED.] can be used legitimately in designing plate girder spans; for the reason that for five years past bridge computers have been using THACHER'S tables of equivalent uniformly distributed live loads in plate girder designing, even if they have not been able to use them in computing stresses in trusses.

It may be possible that if the parabola of moments due to the equivalent uniform load, and a number of moments from concentrations at intermediate points, were platted on the same sheet, some of the latter would pass a trifle outside of the curve; but if so, this would cut no figure, because the maximum bending moment is in most cases the quantity sought for in proportioning such structures; and in determining lengths for cover plates, a good designer will always add 2 or 3 ft. to the length required by theory. The moment parabola referred to affords a very expeditious method of ascertaining the proper lengths of cover plates.

If we plot on cross section paper the loads given in the table, and draw, as nearly as is practicable, through the points indicating the loads a shapely curve, we will find that one or two of the points will not lie therein. This is due to some peculiar relation between the wheel spacing and the span length, and would not occur for the same span with the slightly different wheel spacing of some other similar locomotive; consequently, it would be proper, in preparing tables of equivalent uniformly distributed loads for actual use, to ignore such variations from uniformity and fill out the table from the ordinates to the curve.

A strong point that can be raised in favor of using equivalent uniformly distributed loads for finding bending moments in plate girder spans is that the ordinary engine diagram cannot be employed, for the reason that the greatest bending will nearly always occur when some of the wheels at the head of the train have passed off the span. In consequence one would either need to have at hand a moment diagram with each wheel leading in turn for each standard loading, or would have to discard all diagrams and make a special investigation of moments for each case as it arises, determining each time by experience or by trial which of several wheels placed at mid-span will give the greatest moment. It is the latter method that the writer has used for years when forced into figuring by the concentration method because of competition.

As we have been dealing thus far with plate girder spans exclusively, we will now treat of the end shears on these before passing to trusses. Investigation shows that the amount to be added to the half of the total uniform load on any span in order to equal approximately the end shear is given by the equation: $W = A + BL$, where W is the additional load, L the span length, and A and B are constants that will differ for different engine and car loads. For the engines used in these calculations, $A = 8{,}000$ and $B = 100$.

In the following table is given the results of the calculations:

Span.	W Uniform load.	$\frac{WS}{2}$ Half l'd.	Addit'l load by formula.	Summation.	Calc. end shear.	P. of variation.	
15	5,760	43,200	9,500	52,700	50,880	3.5	Safety.
17½	5,407	47,311	9,750	57,601	57,325	0.5	*Danger.*
20	5,040	50,400	10,000	60,400	62,160	2.8	"
22½	4,993	56,177	10,250	66,427	65,920	0.8	Safety.
25	4,804	60,050	10,500	70,550	70,248	0.4	"
30	4,573	68,595	11,000	79,595	77,457	2.8	"
35	4,327	75,723	11,500	87,223	85,402	2.1	"
40	4,164	83,280	12,000	95,280	93,129	2.3	"
45	3,995	89,887	12,500	102,387	100,114	2.3	"
50	3,860	96,500	13,000	109,500	106,843	2.5	"
55	3,726	102,465	13,500	115,965	113,295	2.4	"
60	3,654	109,520	14,000	123,520	119,950	3.1	"
70	3,490	122,150	15,000	137,150	136,310	0.6	"
80	3,379	135,160	16,000	151,160	153,307	1.4	*Danger.*
90	3,310	148,950	17,000	165,950	169,685	2.2	"
100	3,226	161,300	18,000	179,300	185,622	3.4	"

By consulting the last column it will be seen that the formula assumed will give in most cases a small error on the side of safety. It is really only in the spans exceeding 70 ft. that the error is on the danger side; for the value of W in the 20-ft. span would in practice be increased by the adoption of a uniform curve of loads, as before mentioned.

Moreover the end shear on plate girder spans is by no means an important factor in designing, for two reasons, viz.:

First.—There is nearly always an excess of section in the web of a well proportioned plate girder, and

Second.—The intensity of shearing stress is always taken very low, being 4,000 lbs. for iron and 5,000 lbs. for steel.

The main object in inserting the last table is to show that it is practicable to establish, for any system of live loads, a simple formula for determining readily within a small limit of error the end shears on plate girder spans.

TRUSS SPANS.

Passing now to truss spans, the following table gives the equivalent uniformly distributed load at each panel point of each span considered, which will produce the same bending moment as will the loads for the engine diagram. The averages are for the loads at all the panel points of a span, and not the direct averages of those given in the table:

Panel point.	Spans of 100-ft.	150-ft.	200-ft.	250-ft.	300-ft.
No. 1	3,383	3,283	3,220	3,179	3,151
" 2	3,157	3,145	3,120	3,098	3,083
" 3	....	3,207	3,137	3,116	3,094
" 4	....	....	3,106	3,084	3,068
" 5	....	....	....	3,056	3,047
" 6	....	....	....	....	3,043
Average	3,308	3,215	3,151	3,112	3,085
Greatest safety error by using the average	4.77%	2.23%	1.45%	1.83%	1.38%
Greatest *danger* error by using the average	2.21%	2.07%	2.14%	2.10%	2.09%

It will be observed that the greatest error on the side of danger in any span is very little over 2%, and that with the exception of the 100-ft. span the greatest error on the side of safety is a little less than 2%. The fact that the uniform load gives in general a small error on the side of safety for the chord members, except at the ends of a span, is a good feature; because by placing cars ahead of the locomotives greater chord stresses can often be found than those obtained by the use of the ordinary engine diagram.

As for the 2% error on the side of danger at the ends of span, it will cut but little figure even if it really affect the sections, which it generally will not, because in single track bridges the two panels of bottom chord at each end of span, being stiffened for wind pressure, have always a slight excess of metal; and the inclined end posts, being proportioned for bending, have a great excess of metal, as far as the direct stress is concerned.

Adopting for the web members the same uniform load as the average determined in the last table for the chords, and computing the web stresses therefrom, also those for the same members by means of the engine diagram, we will obtain the results given in the following table.

The results of this investigation cannot be considered anything but satisfactory; for the "Danger" percentages of error are all small (never exceeding 2¼%) and affect the heavier members, while the "Safety" percentages of error affect principally the counters. Setting aside the consideration of the inclined end posts for the reason mentioned previously, we find that the uniform load stresses for main diagonals give a very close coincidence indeed, the variation being hardly worth mentioning. As for the counter stresses, an error on the side of safety is a very good thing, because of both impact and oftentimes adjustment. Moreover, the method of proportioning counters is very variable, some computers deducting the dead load stress of the panel, and others not deducting it; while every conscientious designer always adds something to the section required for small counters in order to provide for uncertainties.

In concluding this subject of Concentrated vs. Uniform Loads, the writer wishes to urge each engineer who discusses this paper to give his opinion concerning the advisability of continuing to use the present laborious method of computing stresses in railway bridges, or of abandoning it and adopting instead tables of equivalent uniformly distributed loads for certain standard, locomotive and car loads, to be adopted by the profession, similar to those hereinafter indicated. It is only by an array of opinion of authorities that railway engineers can be induced to depart from established custom to such an extent as to specify uniform loads when calling for bids on their proposed bridges, and it is, undoubtedly, these gentlemen who keep up the fashion in bridge specifications after that fashion has once been set by specialists.

Span.	Member.	Shear in pounds. By diag'm.	By unif'm ld.	Per cent. of error.	
100-ft.	End post	126,881	124,050	2.23	*Danger.*
	First M. diag	59,429	62,025	4.40	Safety.
	First counter	17,247	20,675	19.9	Safety.
150-ft.	End post	205,255	200,745	2.21	*Danger.*
	First M. diag	134,585	133,830	0.56	*Danger.*
	Second do.	78,142	80,298	2.76	Safety.
	First counter	36,576	40,149	9.77	Safety.
200-ft.	End post	281,874	275,716	2.18	*Danger.*
	First M. diag	209,992	208,787	1.53	*Danger.*
	Second do.	148,784	147,705	0.72	*Danger.*
	Third do.	97,484	98,470	1.01	Safety.
	First counter	55,768	59 082	5.94	Safety.
	Second do.	26,220	29,541	12.66	Safety.
250-ft.	End post	357,668	349,875	2.18	*Danger.*
	First M. diag	285,278	279,900	1.88	*Danger.*
	Second do.	220,844	217,700	1.42	*Danger.*
	Third do.	164.804	163,275	0.93	*Danger.*
	Fourth do.	116,264	116,625	0.31	Safety.
	First counter	75,887	77,750	2.45	Safety.
	Second do.	43,645	46,650	6.85	Safety.
300-ft.	End post	433,260	424,182	2.10	*Danger.*
	First M. diag	330,438	333,485	1.93	*Danger.*
	Second do	293 893	289,215	1.59	*Danger.*
	Third do	234,684	231,372	1.41	*Danger.*
	Fourth do	181,734	179,356	0.97	*Danger.*
	Fifth do	135,034	134,967	0.05	*Danger.*
	First counter	95,206	96,405	1.26	Safety.
	Second do	62,431	64,270	2.95	Safety.

THE PROPER LIVE LOADS FOR MODERN BRIDGE SPECIFICATIONS.

The writer would suggest the following on this head Fig. 4):

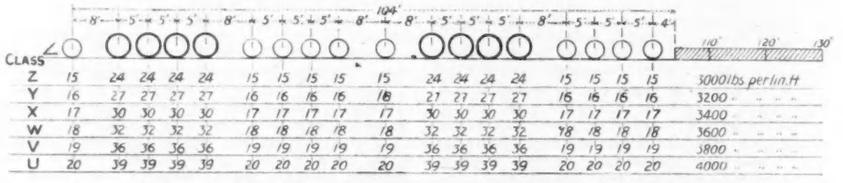


FIG. 4. PROPOSED LOAD DIAGRAMS.

(Loads Given in Thousands of Pounds.)

Class *Z* of this series corresponds practically to COOPER'S Class *A*, and the Class *U* to his "Lehigh Heavy Grade Engines." It will be observed, however, that there are but two wheel spacings employed, and that these are in even feet. This is merely for the sake of simplifying calculations; and any one who has for years struggled with COOPER'S spacing of feet and odd inches when reduced to decimals of a foot will agree with the writer that the change is an improvement.

If the general sentiment of the profession prove to be in favor of the preceding standard loads, the writer will see that all of the necessary "equivalents" in accordance with this proposed system shall be calculated, tabulated and presented to the American Society of Civil Engineers within a reasonable time. The regularity of increase of loads for the various proposed classes can be seen by inspection, so if in the future heavier loads than the "Lehigh Heavy Grade Engine," with its car load of 4,000 lbs. per foot, be employed, it will be a simple matter to extend the series.

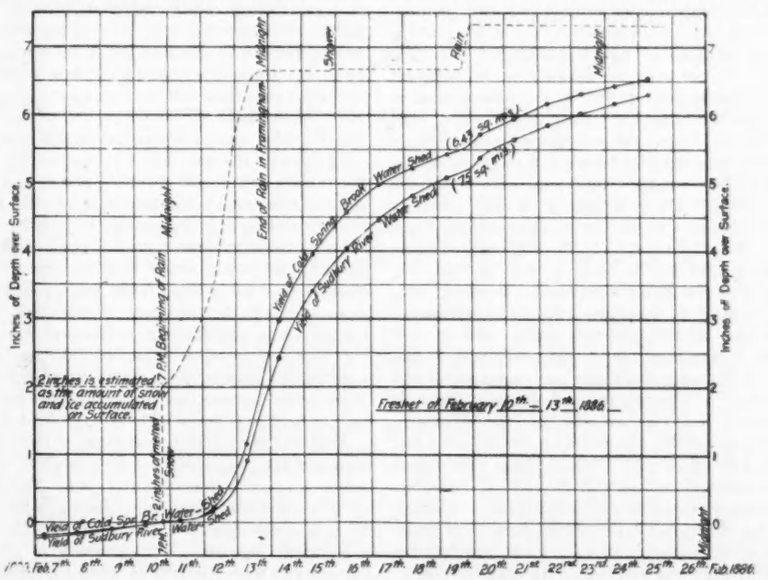
COOPER'S specifications provide alternative engine loads consisting of 100,000 lbs. equally distributed on two pairs of drivers, 7 ft. center to center, for his heaviest load, and reduced proportionately for his lighter loads. As these must be supposed to act without any other live load, it is evident that they can affect only certain bridge members for very short panels. But as the tendency of modern bridge designing is toward the use of longer and longer panels, it is evident that these alternative loads are unnecessary, unless it be for the wooden ties, in the proportioning of which judgment rather than figuring ought to govern. If we were to compare the moments found by Mr. COOPER'S alternative live load for Class *A* with those obtained from our previously found equivalent uniformly distributed loads *after their adjustment by the curve*, we would see that there is only one case where the former would exceed the latter, and that by only 1.4%, hence it is reasonable to conclude that, for spans and panels exceeding 15 ft., the alternative load is unnecessary.

(To be continued.)

Discharge from the Sudbury River Watershed Feb. 7-26, 1886.

The instances in which it can be accurately determined what proportion the actual discharge from a given watershed bore to the quantity of rain falling upon it are still not many, and especially rare are those showing about what maximum yield may be expected under favorable conditions. We reproduce in the accompanying diagram one showing perhaps as large a percentage of discharge as can ever be expected, under conditions when a very heavy warm rain is combined with a considerable quantity of snow on the ground and a frozen, non-absorbing soil. The diagram and following abstract of facts are contained in a recent paper by Mr. DESMOND FITZGERALD, Resident Engineer Boston Water-Works, (Trans. Am. Soc. C. E., September, 1891).

The storm began at 10 A. M. on Feb. 10, 1886, and was central over Rhode Island, where about 8 ins. of rain fell. On 1,500 sq. miles in all the rainfall was over 7 ins., and on 7,600 sq. miles it was over 4 ins., the measured fall in the Sudbury River valley being some 4.64 ins. The heavy bed of snow was estimated to be equivalent to 2 ins. of water, this being of course a somewhat doubtful element. The melting of this snow caused the remarkable prolongation of the heavy flow shown in the diagram, which ended only when the 6.5 ins. of the estimated total


Midnight
Shower
Rain
Midnight
End of Rain in Framingham
Midnight
Yield of Cold Spring Brook Water Shed (6.43 sq. mls.)
Yield of Sudbury River Water Shed (75 sq. mls.)
Beginning of Rain
7 P.M.
2 inches is estimated as the amount of Snow and Ice accumulated on Surface.
2 inches of melted Snow
Freshet of February 10th to 13th, 1886
Yield of Cold Spring Brook Water-Shed
Yield of Sudbury River Water-Shed
Inches of Depth over Surface.
Inches of Depth over Surface.
Feb 7th 8th 9th 10th 11th 12th 13th 14th 15th 16th 17th 18th 19th 20th 21st 22nd 23rd 24th 25th 26th Feb 1886

CUMULATIVE DIAGRAM OF SIMULTANEOUS PRECIPITATION AND YIELD OF SUDBURY RIVER AND COLD SPRING BROOK WATER SHEDS.

of 6.64 ins. of rain and snow had run off, 14 days after the heavy rain began. The observed maximum temperatures were:

11th	12th	13th	14th	15th	16th
37° F.	37°	46°	51°	54°	54°

The distribution of the rainfall as respects time is somewhat indeterminate, but is believed to be fairly represented by the dotted line in the diagram, which also shows (1) the yield of the entire Sudbury Valley and (2) the yield of the Cold Spring Brook watershed, which is a small fraction of that valley. The watershed is thus described:

The Sudbury River watershed is one of the sources of water supply of the city of Boston. It is 25 miles west of the city. Its area is about 75 sq. miles, varying slightly from this amount, as is shown in the accompanying table. [Feb. 13 to 18, the area was 74.66 sq. miles; thereafter 75.20 sq. miles Feb. 6 to 12, and 19 to 21. Table not reproduced. —ED.] The topography represents a fair average New England watershed. About 38 % of the surface is covered with woods. The Cold Spring Brook watershed, a fraction of the above area, covers 6.43 sq. miles. The boundaries of both watersheds have been determined by survey. The gagings are made daily at 7 A. M. The yields are determined by the flows over the dams at the outlets of the respective watersheds, modified by the gains or losses in the storage basins upon their surfaces. The accompanying table [omitted] gives the yields in gallons; the yields per square mile in gallons; these yields reduced to their equivalent depth in inches upon the watersheds; and in the final column in each case, the successive additions from the time when the rain began, the latter point being taken as zero. The yields preceding this time are tabulated as minus quantities in order to separated them from the total collections which follow and which are due to the rain.

The dotted line on the diagram showing the rainfall is started 2 ins. higher than the "yield" lines, to allow for the 2 ins. of snow upon the ground at the beginning of the rain. The two solid lines, representing the yields of the two watersheds, start from zero at the beginning of the rain, and represent at any point the *total* yield at that point reckoned from the beginning of the rain. It will be noticed that the yields previous and subsequent to the rain were small, and they are shown in the diagram by the flat inclination of the lines of flow as they approach the storms. Consequently the large flows were due entirely to this particular storm.

For this reason it is safe to assume that out of the 6.64 ins. total rain and melted snow came the 5.08 ins. on the Sudbury and 5.43 ins. on the Cold Spring Brook watersheds which were collected in the first 5 days after the beginning of the rain. It will be noticed that the *maximum yield per 24 hours* on the Sudbury watershed was equal to 1.54 ins. in depth, and on Cold Spring brook watershed to 1 801 ins. The maximum rate of yield on the larger water shed occurred between 7 A. M. and 12 M. of Feb. 13, the rain beginning at 7 A. M. on Feb. 10. For this period the flow averaged at the rate of 2,136,000,000 galls. in 24 hours, or 1.646 ins. in depth per day. On March 28, 1876, 10 years before, almost exactly the same yield was gaged, viz., 1.559 in. in depth per 24 hours.

Mr. FITZGERALD states his conclusions as follows:

The dams on the Boston Water-Works are proportioned for a continuous flow of 6 ins. depth per day over their watersheds. This is not an unreasonable provision for maximum flow, as will be apparent on careful consideration. Mr. JAMES B. FRANCIS has given the results of his investigation of the great storm of October, 1869,* when 12.35 ins. fell at the center of the storm in Connecticut. At Middletown, 7.15 ins. fell in 24 hours, and it is possible that at the center of the storm considerably more than 8 ins. fell in one day. If such a rain as this should fall on frozen ground covered with a body of snow, and accompanied by a high temperature, it might create a flow equal to 5 or 6 ins. in depth upon a watershed in 24 hours.

The omitted table shows for the two valleys the following rates of discharge in inches of depth on the watershed for the days of heaviest discharge:

	Sudbury.	Cold Spring Brook.
Feb. 12	0.722	0.949
" 13	1.540	1.801
" 14	0.904	0.977
" 15	0.646	0.618

* Trans. Am. Soc. C. E. August, 1878.

A HYDRAULIC CEMENT MILL, with a capacity of 3,000 barrels per day, it is said, will shortly be erected at Binnewater, in the Rosendale region, to take the place of one recently destroyed by fire.

GAS LIGHTING FOR SUBURBAN CARS has made such progress on the Chicago & Northwestern Ry. that that road has now 150 cars thus lighted. It is also equipping much of its other car stock.

PERSONALS.

Mr. W. M. HUGHES has been appointed Bridge Engineer in the Engineering Department of Chicago.

Mr. L. E. COOLEY, formerly Chief Engineer to the Chicago Drainage Trustees, has been elected one of the trustees.

Mr. GEORGE D. WADLEY, Chief Engineer and General Superintendent of the South Bound R. R., of Georgia, has been appointed General Manager of that road.

Mr. H. C MOTT, JR., has been appointed Assistant Superintendent of the Wyoming Division of the Burlington & Missouri River R. R., with headquarters at Alliance, Neb.

Mr. ALBAN EAVENSON has been appointed Acting Chemist of the Lehigh Valley R. R., vice Mr. C. P. COLEMAN, transferred to the office of the General Eastern Superintendent.

Mr. JOHN J. BURNS, Superintendent of Transportation of the Denver & Rio Grande R. R., has been appointed Superintendent of the First division of that road, with headquarters at Pueblo, Col., vice Mr. W. A. DRUEL, resigned.

Mr. WM. L. SAUNDERS, engineer of the Ingersoll Rock Drill Co., and well known in connection with the study of air compression, will deliver a lecture before the Franklin Institute, Philadelphia, on the evening of Dec. 11, on the subject of "The Compressed Air Power of the Future."

Mr. CHARLES ADOLPHE ALPHAND, Director of Public Works of Paris, France, died Dec. 6. He was born in Grenoble in 1817, and was educated in a polytechnic school there. In 1839 he was engaged in superintending the building of bridges and railways near Bordeaux. On going to Paris in 1854 he was appointed Chief Engineer of Improvements, and designed much of the work on the Champs Elysées and Bois de Boulogne. He was in charge of the landscape and grading work at the grounds of the exposition of 1867.

SOCIETY PROCEEDINGS.

Engineers' Club of St. Louis.—The twenty-second annual meeting was held Dec. 2. The following gentlemen were nominated for office for 1892: President, J. B. Johnson; Vice-President, B. L. Crosby; Secretary, Arthur Thatcher; Treasurer, C. W. Melcher; Librarian, R. E McMath; Directors, George Burnett and B. H. Colby, and Board of Managers, J. B. Johnson and J. A. Laird. The report of the Executive Committee showed that the club had held 19 meetings during the year. The expenses were $1,554. The papers promised for the ensuing year were as follows: "Recent Survey of St. Louis—Its Methods and Results," by B. H. Colby; "Pollution of Hudson River," by Prof. C. C. Brown; "Progress of Mapping in Missouri," by Arthur Winslow; "Methods and Results of Precise Leveling," by O. W. Ferguson; "Elements Involved in Rapid Transit," by B. J. Crow; "Construction of Electric Railway Power Stations," by B. J. Arnold; "Maximum Stress in Draw-Bridges," by Prof. M. A. Bowe; "An Inclined Cable Railway for Transferring Freight Cars," by Edward Flad; "Steam Generation with Hydro-Carbon Fuels," by Dr. Wellington Adams; "Steam Shovels and Steam Shovel Work," by E. A. Herman; "Notes on the Harcuver Line," by Frank Nicholson; and "Tunnel Timbering in Soft Ground," by J. W. Abbott. Secretary Thatcher's report showed that 20 papers had been read during the year, and that there was a resident membership of 136, a non-resident membership of 45 and one honorary member, Wm. E. Worthen, of New York.

American Institute of Mining Engineers.—The 61st meeting, and 22d annual meeting, will be held at Baltimore, Md., beginning Feb. 16, 1892. Mr. J. W. Tyson, Baltimore, Md., is the chairman of the local committee, and will answer all questions regarding local arrangements. The mining, preparation and utilization of phosphates will be made a special topic of discussion. In addition to this topic, the following will also be open for discussion: The concentration of iron ore, the preparation and utilization of small sizes of anthracite, and tests of structural wrought-iron and steel.

Iowa Civil Engineers' and Surveyors' Society.—The fourth annual meeting will be held in the Commercial Club Rooms of the I. O. O. F. Building, Burlington Ia., commencing Dec. 29, 1891, at 2 P. M. Practicing civil engineers and surveyors are invited to attend.

SETH DEAN, *Secretary.*

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST..... .....BUSINESS MANAGER

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Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the art or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

COMING TECHNICAL MEETINGS.

Western Railway Club.—Dec. 15. Rooms, Rookery Building, Chicago. Secy., W. H. Marshall.
Engineers' Society of Western Pennsylvania.—Dec 15. Secy., J. H. Harlow, Pittsburg, Pa.
Engineers' Club of St. Louis.—Dec. 16. Secy., Arthur Thatcher, Odd Fellows' Building.
American Society of Civil Engineers.—Dec. 16. Secy., Francis Collingwood, 127 East 23d St., New York.
Boston Society of Civil Engineers.—Dec. 16. Secy., S. E. Tinkham, City Hall.
Canadian Society of Civil Engineers.—Dec. 17. Secy., H. T. Bovey, 112 Mansfield St., Montreal, P. Q.
Engineers' Club of Cincinnati.—Dec. 17. Secy., J. F. Wilson.
New York Railroad Club.—Dec. 17. Rooms, Gilsey House.
Scandinavian Engineering Society of Chicago.—Dec. 17. Secy., T. G. Philfeldt, 118 Adams St.
Montana Society of Civil Engineers.—Dec. 19. Helena.
Engineers' Club of Philadelphia.—Dec. 19. House, 1122 Girard St. Secy., H. Murphy.
Iowa Civil Engineers and Surveyors Society.—Annual meeting at Burlington, Dec. 29. Secy., Seth Dean Glenwood.
Technical Society of the Pacific Coast.—Jan. 1. Secy., O. von Geldern, 819 Market St., San Francisco.
Swedish Engineers' Club.—Jan. 2. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
Northwest Railroad Club.—Jan. 2. Rooms, Union Station, St. Paul.
Civil Engineers' Society of St. Paul.—Jan. 4. Secy., C. L. Annan.
Engineers' Club of Kansas City.—Jan. 4. Rooms, Baird Building. Secy., H. Goldmark.
Western Society of Engineers.—Jan. 6. Secy., J. W. Weston, 320 La Salle St., Chicago.
Engineers' Club of Minneapolis.—Jan. 7. Rooms, Public Library Bldg. Secy., F. W. Cappelen.
Association of Civil Engineers of Dallas.—Jan. 8. Secy., E. K. Smoot, 803 Commerce St.
Civil Engineers' Club of Cleveland.—Jan. 8 Secy., A. H. Porter, 50 Euclid Ave.
Atlanta Society of Civil Engineers.—Jan. 12. Secy., Parker N. Black, Capitol Block.
Denver Society of Civil Engineers.—Jan. 12. Secy., Geo H. Angell.
Northwestern Society of Engineers.—Jan. 12. Rooms, Occidental Block, Seattle. Secy., E. H. Warner.
Civil Engineers' Association of Kansas.—Jan. 13. Secy., J. C. Herring Wichita, Kan.
New England Railroad Club.—Next meeting Jan. 13. At United States Hotel, Boston. Secy., F. M. Curtis.
Engineering Association of the Southwest. Jan. 14. Secy., O. H. Landreth, Nashville, Tenn.
Northwestern Track and Bridge Association.—Jan. 15. Rooms, Union Station, St. Paul.
Southern and Southwestern Railway Club.—At Atlanta, Ga., Jan. 21. Secy., F. A. Charpiot, Macon, Ga.

OUR readers will perhaps have been surprised not to have yet seen in our columns any abstracts from "advance sheets" of the report of the Interstate Commerce Commission's Statistician, such as have appeared in a number of our enterprising technical contemporaries; but the reason is we do not care to make mere reprints of newspaper abstracts of documents of such importance, and no "advance sheets" have yet been issued to anyone, though the daily press was permitted to issue some sort of a summary of the report. This we felt quite sure of from the fact that no advance sheets of the report had reached our table: but to make assurance doubly sure we telegraphed to the Secretary of the Commission, and received the following response:

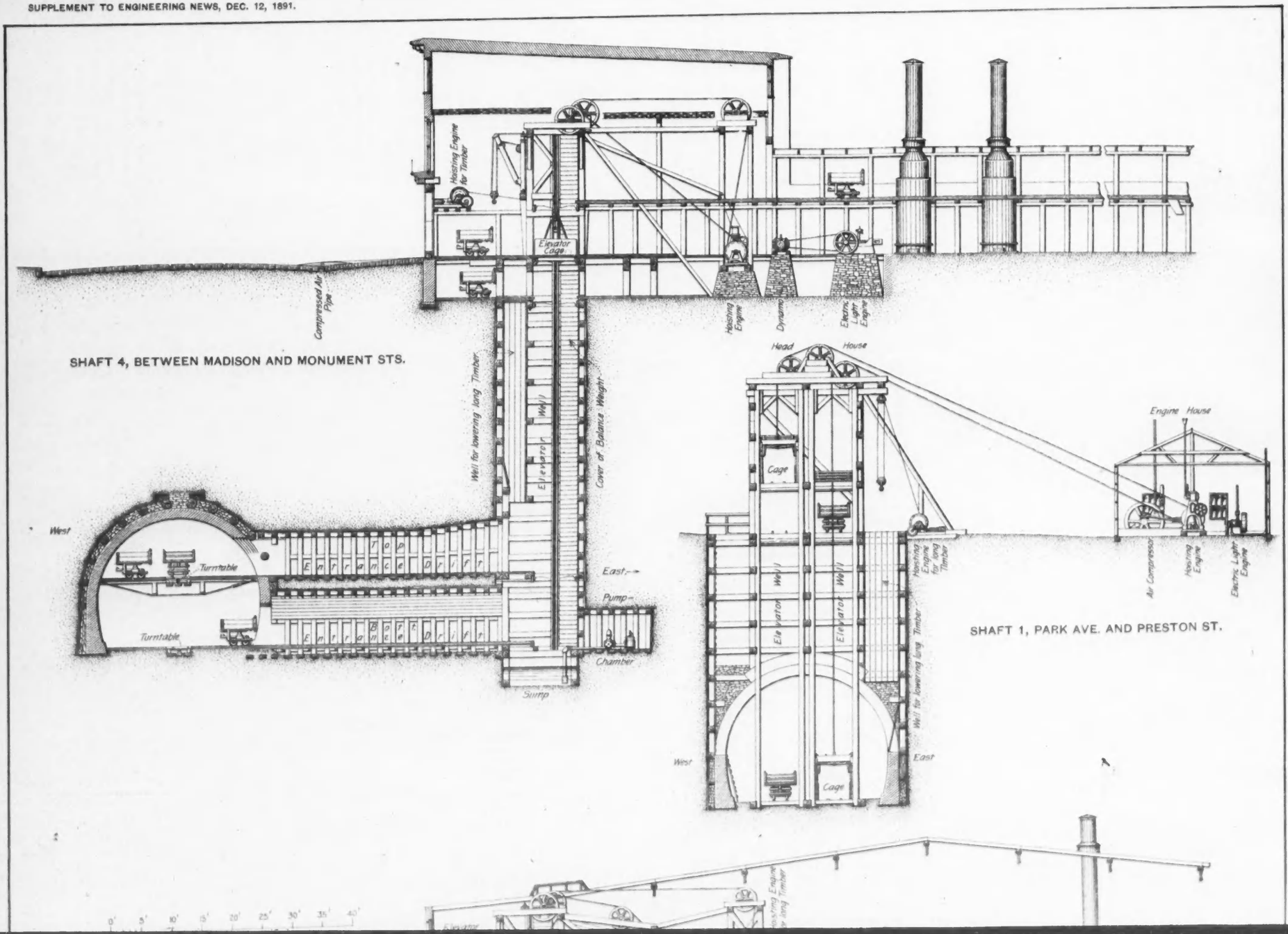
> Advance sheets of statistical report with printer. None have been delivered, and do not expect them until next week.

THE affairs of the World's Columbian Exposition, to be held at Chicago in 1893, are now so well established as to give reasonable assurance that it will be not only the largest but one of the most beautiful and attractive expositions ever had, and the work is already so well advanced as to warrant us in beginning to present complete and detailed information respecting the works and the general matters of the Exposition. We have therefore taken steps to obtain this information, more especially in regard to the construction of the main buildings, and shall present the same from time to time. On a recent visit to Chicago the work was found to be much farther advanced than is easily appreciated from mere verbal descriptions or than we believe is in fact generally appreciated in this section of the country. Compared with the progress of the Philadelphia exposition of 1876 in the same period of time, the work is much more advanced. In later articles we shall present more detailed information in regard to the progress made, and it will suffice to say here that at the lower end of the Park all the main buildings are commenced, the iron roof of the Mines and Mining Building is erected, and the exterior of the Woman's Building is already covered with "staff" and has much of the decorative work in place. The upper end of the park, where will be located the buildings of the States and of foreign nations, is being graded and improved, driveways made, and avenues of trees planted. Jackson Park, which is the site of the Exposition, has a very attractive location on the lake front, which leaves little to be desired in this respect. It is reached now by the suburban trains of the Illinois Central R. R. and by the Cottage Grove Ave. line of cable railway. Arrangements are being made for access from other main railways. The Chicago & South Side Elevated Ry. will have a terminal at the Exposition, and connection will be made with another cable railway. Water transportation on a large scale from Chicago and lake ports is also being arranged. On the lake front of the park is a broad driveway and promenade, and strangers who view the expanse of water stretching to the horizon, and dotted with ships and steamers, will find it difficult to realize that they are looking across a fresh water lake, especially in rough weather.

AMONG Chicago people there is considerable feeling, sometimes expressed indignantly, at the attitude of New York, city and state, toward the exposition, and the indifference thus far shown toward its interests. The general assumption is that jealousy is the cause of this attitude, and that, having failed to secure the Exposition for itself, New York is not inclined to aid it when held elsewhere, but is rather inclined to belittle it. It is more likely, however, as stated in a recent speech by Mr. CHAUNCEY M. DEPEW, that New York City is so absorbed in its own business affairs and interests as to be indifferent to matters outside. Whatever the reason may be, it is undeniable that New York is behindhand thus far in giving its countenance and aid to an exposition which, whether with or without New York's aid, will almost certainly be one of the greatest, if not the greatest, of its kind in every way. It needs to be more keenly appreciated here that it will be a national and not a mere state or local exposition. So important a state as New York should take a leading part and should have a fine building and fine display. Fortunately the most important aid which New York can give will come from individual exhibitors, and that is not likely to be neglected. It will be all the less likely to be neglected if possible exhibitors realize how far the actual work has advanced, and how nearly certain it now is that the exposition will be a brilliant success.

THE disputed points of bridge construction can never by possibility be all eliminated, for it must continue to be an advancing art in which the element of personal judgment will find wide scope. But practice is to-day nearly uniform on many points heretofore disputed, while there are certain points still disputed which must inevitably cease to be so. Questions which depend on a variety of varying conditions, like the proper unit stresses for different material, &c., &c., will never be definitely settled, since the material itself is constantly varying with the progress of the arts; but there are certain other still disputed points, the conditions of which are substantially invariable, and on which one side must be wrong. In regard to these we may be sure that "great is truth, and it will prevail," despite of those who for one reason or another may for a time favor the wrong conclusion. Among the questions of this class, that of the proper assumption for rolling load in computing bridge strains, whether to take the actual spacing and loads of the separate wheels of one or more actual locomotives, or to do with the locomotive load as is done with the car load, assume a simpler loading which represents with practical accuracy the effects of the more complex "actual wheel loads," is preëminently one. The nature of the problem does not change with time. It is a mere question of fact, capable of a categorical answer. The question is merely: Is there any reason to believe that the strains obtained by separate computation of the effect of each wheel of some one or two or three particular locomotives will come appreciably nearer to the strains of actual service than those obtained by computation from much simplified typical loadings? If the true answer be yes, separate wheel loads should continue to be used; if no, they should be abolished.

OUR own position on this question is not doubtful. We believe that the separate wheel load computations are worse than a mere waste of time; that they have a distinctly injurious tendency, for reasons which we have many times given, and which are in part ably summarized in the first part of Mr. WADDELL'S paper abstracted in another column. We commend that part of the paper especially to the attention of every reader interested in bridge construction. We fully recognize the fact that the able engineers who originated this system of computation by separate wheel loads not only did so with the best of motives, but did actually advance the cause of good bridge designing thereby, by leading to a more accurate proportioning of different members for the strains which they would have to sustain in practice. We are quite ready to grant that this method must necessarily continue to be used at



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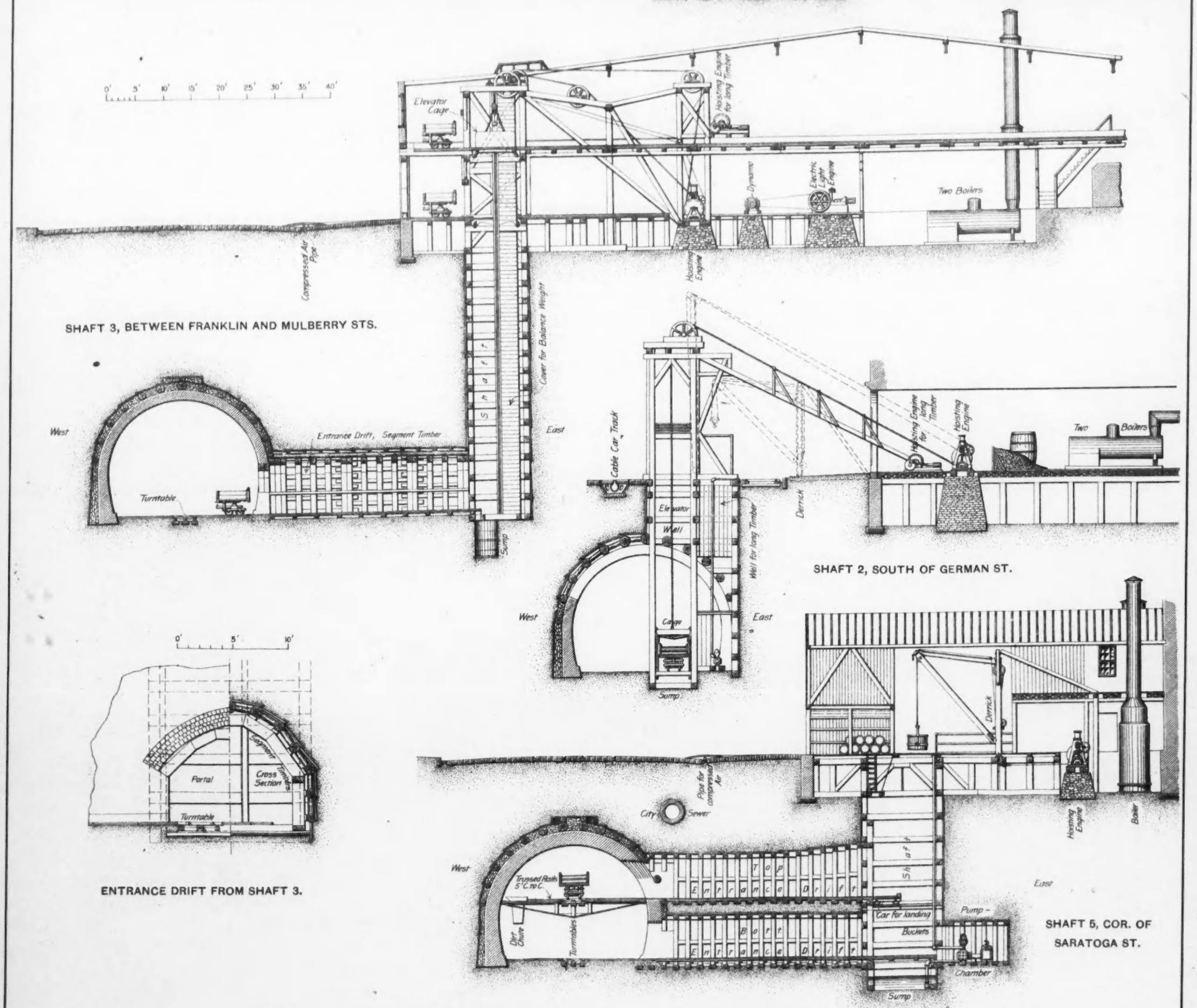
SHAFT 1, PARK AVE. AND PRESTON ST.



SHAFT 3, BETWEEN FRANKLIN AND MULBERRY STS.

SHAFT 2, SOUTH OF GERMAN ST.

ENTRANCE DRIFT FROM SHAFT 3.

SHAFT 5, COR. OF SARATOGA ST.

Shafts for Howard St. Tunnel, Baltimore Belt Railroad.

Richard Randolph, Chief Engineer. Ryan & McDonald, Contractors.

Chas. Hart & Sons, Lith. 30 Vesey St., N. Y.

times for checking the correctness of simpler processes used in the actual work of design. But no feasible method of computation takes account of the great dynamic stresses which are in practice added to the static, but which are, from their nature, not susceptible of exact analysis; and no feasible number of "typical locomotives" can cover all the possible forms of wheel-base which not only may run, but probably will run, over any new bridge. Therefore, as we must and do guess at the proper allowance to be made for a large part of our strains (in the specious forms of low and varying unit stresses), it is simply absurd to insist that the remaining fraction of the strains, which, *under given assumptions*, we can figure out to a nicety, should be weighed in a chemist's balance. It is altogether too much like JOHN PHOENIX'S famous "military survey" [ENG. NEWS., Dec. 31, 1887], where he paced off his circumference, and then figured out the diameter to seven places of decimals.

THAT the problem of mechanical flight is no longer one which must be looked upon as visionary or impracticable under the limitations of our present knowledge, but rather one on which MAXIM and other actual experimenters are hopefully working, may be readily seen by comparing the results of Prof. LANGLEY'S* experiments in aerodynamics as heretofore abstracted in this journal with the known weight of various forms of steam engines. Prof. LANGLEY found that planes of 30 × 4.8 ins. and at any given angle with the horizontal began to "soar," or sustain their own weight, at about a fixed speed, and that the power required to propel them was also approximately constant and varied inversely as the speed, his final results being as follows for a series of such planes at least 4 ins. apart vertically and weighing about 1.1 lbs. per sq. ft. of inclined surface:

WEIGHT OF PLANE THAT 1 H. P. WILL DRIVE.

Inclination of plane.	Soaring speed, miles per hour.	Weight in lbs.
45°	25	15
30°	23¾	29
15°	25	58
10°	27¾	77
5°	31	122
2°	41¾	209

On the other hand, the weight of various steam engines and boilers (apart from fuel supplies) is, even on Atlantic liners, where minimum weight per horse power is of no great moment, 280 lbs., in new modern war vessels 160 to 170 lbs., running down to 80 lbs. or less in torpedo boats and vessels of that kind. In locomotives (apart from the tender) the usual weight per horse power is 110 to 175 lbs. Mr. MAXIM declares that much better than any of these figures can now be obtained, but it is evident without demonstration that by the use of aluminum, hollow compression parts, special types of boilers, &c., &c., the necessary power to drive and sustain a suitably designed air ship *after it is once under way* is even now attainable, and the only (but very serious) remaining dubious elements are the proper design of the details and the problem of landing and starting. While these excepted elements involve immense difficulties, they are in their essence mere questions of detail, which can be hopefully attacked without waiting for any addition to our present mechanical resources. A beginning once made, it is hard to say what may follow, especially if we should ever be able to get 75 to 80 per cent. of the power out of heat, instead of only 5 to 10 per cent.

WE notice that Commodore FARQUHAR, Chief of the Bureau of Yards and Docks, in his last annual report recommends an increase in the number of civil engineers employed in the navy, and that the full corps contain 20 men, eight of these to be assistant engineers. He further recommends that two engineers be selected from civil life and two from graduates of the Naval Academy, each year, until the prescribed number is obtained, and thereafter all vacancies in the grade of assistants are to be filled by selection from graduates of the Academy.

If this recommendation is approved of, as it should be, the present corps of civil engineers in the navy will be doubled. There are now just ten civil engineers to perform constantly increasing and important duties at the Bureau of Yards and Docks and at fourteen navy yards and shore stations scattered along both coasts of the United States, and valued at over $36,000,000, not including real estate, and four of these ten engineers are now on department duty, leave of absence or waiting orders. The active staff is almost absurdly inadequate, when we consider that the new navy we are now constructing means practically new dry docks, new buildings and shops of all kinds, and a radical change from a plant designed for a now obsolete type of wooden warship to that adapted to the construction and care of that intricate piece of mechanical engineering, a cruiser or line-of-battle ship of the present day. These changes all call for the services of skilled and experienced civil engineers, and the present corps, notwithstanding its individual efficiency, is altogether too small to properly perform the duties which the present naval activity forces upon it. The recommendation of Commodore FARQUHAR therefore, as to an increase in the engineering staff of the navy, is timely, and should be at once carried into effect.

As to the method of appointment proposed by Commodore FARQUHAR, the law of 1864, which provided for the education of civil engineers at the Naval Academy, is practically a dead letter, and later statutes omit any mention of such law. We can see that it is essential that the naval civil engineer should broadly understand the construction, details and management of a modern warship, and this education can best be secured at the academy. But to perform his full engineering duties even as an assistant engineer he must be well grounded in hydraulic engineering, the design of roofs and buildings, submarine construction, and in that special engineering knowledge which, to the best of our information, does not form an important part of the Academy course. Trained civil engineers are wanted, with some knowledge of naval construction, and it would seem that a competitive examination, open to all aspirants, would best secure the end in view. This examination would be open to graduates of the Academy, and if that institution can furnish the better material the service in no wise suffers by making the competition a public one. The present very efficient corps was entirely recruited from civil life.

THE report of the Secretary of the Navy, elsewhere given in abstract, plainly points out a naval advance in which the United States can well take pride, but it also further shows the absolute necessity of continuing on the lines of the last eight years' progress. Our old wooden navy is altogether worthless and has practically disappeared. We have only thirteen modern war ships in commission, and this list counts the *Petrel*, *Cushing* and *Vesuvius*, all of unimportant size. By 1893 we can probably add a score of ships to this list, and among them at least three worthy to rank with the best armored and armed war ships of modern times; but even then our new navy will be far removed from what the wealth and importance of this country would warrant and common prudence would dictate. The remarks of Secretary of the Navy DOBBINS, quoted in Mr. TRACY'S report, apply admirably to the present situation, and none of our readers will be inclined to doubt that had the United States presented such an array of modern war ships as her true interests demand and as she could well afford, we should never have seen little Chile assume the defiant attitude now accredited to her.

But we are now building a most creditable navy, and our naval engineers have so improved upon the practice of other nations that, type for type, we surpass them in our later ships in speed, armament, coal endurance and general efficiency. Within less than eight years we have done what Europe once declared was impossible in a generation. We have turned out wonderfully good war ships from our own yards; we have introduced the manufacture of armor and by American methods produce the best armor plate yet tested anywhere; we have established and equipped with American appliances our gun foundries, and make our own guns and armor piercing projectiles, and lastly have so improved upon the manufacture of high power guns and their explosives that we need no longer go abroad for experience or methods in what was so lately to us a new departure. When it is considered that not only these ships, but the means of building and arming them had to be created, and that in so short a time, the wonderful resources and capabilities of this country are made apparent. We have made an excellent start and it remains for our law makers to see to it that we go ahead actively and efficiently, until the United States regains at least a goodly portion of that naval supremacy and commercial importance lost in the last twenty-five years.

THE President, in his annual message, makes the following very earnest, sound and well-put plea for the governmental backing of the Nicaragua Canal project. Rarely or never has any President given so emphatic and unqualified an indorsement to any project involving a pledge of the national credit, but with no politics in it. We cannot but hope and believe that this message and the unanimous report of the Senate Committee on Commerce last year to the same effect, correctly indicate the view which the members of both houses of Congress will take without distinction of party when this most important measure comes before them.

The annual report of the Maritime Canal Co. of Nicaragua shows that much costly and necessary preparatory work has been done during the year, in the construction of shops, railroad tracks, and harbor piers and breakwaters, and that the work of canal construction has made some progress.

I deem it to be a matter of the highest concern to the United States that this canal, connecting the waters of the Atlantic and Pacific Oceans and giving to us a short water communication between our ports upon those two great seas, should be speedily constructed and at the smallest practicable limit of cost. The gain in freights to the people and the direct saving to the Government of the United States in the use of its naval vessels would pay the entire cost of this work within a short series of years. The report of the Secretary of the Navy shows the saving in our naval expenditures which would result.

The Senator from Alabama (Mr. MORGAN), in his argument upon this subject before the Senate at the last session, did not overestimate the importance of this work when he said that "the canal is the most important subject now connected with the commercial growth and progress of the United States."

If this work is to be promoted by the usual financial methods and without the aid of the government, the expenditures in its interest-bearing securities and stocks will probably be twice the actual cost. This will necessitate higher tolls and will constitute a heavy and altogether needless burden upon our commerce and that of the world. Every dollar of the bonds and stock of the company should represent a dollar expended in the legitimate and economical prosecution of the work. This is only possible by giving to the bonds the guarantee of the United States Government. Such a guarantee would secure the ready sale at par of a 3% bond from time to time, as the money was needed. I do not doubt that, built upon these business methods, the canal would, when fully inaugurated, earn its fixed charges and operating expenses. But if its bonds are to be marketed at heavy discounts and every bond sold is to be accompanied by a gift of stock, as has come to be expected by investors in such enterprises, the traffic will be seriously burdened to pay interest and dividends. I am quite willing to recommend Government promotion in the prosecution of a work

*"Experiments in Aerodynamics." By S. P. LANGLEY. Published by the Smithsonian Institution.

which, if no other means offered for securing its completion, is of such transcendent interest that the Government should, in my opinion, secure it by direct appropriations from its Treasury.

A guarantee of the bonds of the Canal Company to an amount necessary to the completion of the canal could, I think, be so given as not to involve any serious risk of ultimate loss. The things to be carefully guarded are the completion of the work within the limits of the guarantee, the subrogation of the United States to the rights of the first-mortgage bondholders for any amounts it may have to pay, and, in the meantime, a control of the stock of the company as a security against mismanagement and loss. I most sincerely hope that neither party nor sectional lines will be drawn upon this great American project, so full of interest to the people of all our states, and so influential in its effects upon the prestige and prosperity of our common country.

ANOTHER passage of the message of much interest to railway men, and with the substance of which we heartily sympathize, is the following on train safety appliances:

I have twice before urgently called the attention of Congress to the necessity of legislation for the protection of the lives of railroad employés, but nothing has yet been done. During the year ending June 30, 1890, 308 brakemen were killed and 7,841 maimed while engaged in coupling cars. The total number of railroad employees killed during the year was 2,451, and the number injured 22,390. This is a cruel and largely a needless sacrifice. The government is spending nearly $1,000,000 annually to save the lives of shipwrecked seamen; every steam vessel is rigidly inspected and required to adopt the most approved safety appliances. All this is good; but how shall we excuse the lack of interest and effort in behalf of this army of brave young men who in our land commerce are being sacrificed every year by the continued use of antiquated and dangerous appliances? A law requiring of every railroad engaged in interstate commerce the equipment each year of a given per cent. of its freight cars with automatic couplers and air brakes would compel an agreement between the roads as to the kind of brakes and couplers to be used, and would very soon and very greatly reduce the present fearful death rate among railroad employees.

Undoubtedly the question of a choice between the various types of the M. C. B. coupler is not yet far enough advanced for final decision, but *the type itself* and the exterior lines thereof are now fixed beyond possibility of change, and beyond desire therefor among the hundreds of progressive railway men who have taken the lead in the movement so far. It is necessary for the protection of these officials who have already done so much that the negligent and indifferent should not be allowed to delay corresponding action any longer.

The Future of American Water-Works Construction.

In our issue of last week we reviewed the growth of American water-works by numbers and population supplied and found that in the future the construction of new works will be limited, almost wholly, to towns of small size. This is true both because the larger towns are already supplied and because the growing municipalities of the future will, most of them, secure works before they have attained to any considerable size.

The coming field for engineers and all others interested in water-works construction will be, as stated last week, in connection with the improvement, extension and general enlargement of existing works, especially with the improvement of the quality of water supplied. Filtration, aeration and sedimentation present a large field, and one which, except in the first particular, has been scientifically worked only here and there in this country. The use of meters and other means of reducing the excessive consumption of water in most of our cities awaits more extended attention than it has yet received. While this is more especially within the province of the water-works manager, there is no reason why it should be left so entirely to him or be entirely ignored, as it has been in the past.

Now and then an engineer, when called upon to remedy an alleged inadequate water supply, suggests that the abolition of waste is all that is necessary, but generally no mention is made of this phase of the question, or, if so, only in an incidental way.

In addition to the above, there will in the future be an increased demand for experienced engineers to fill the offices of superintendents of water-works. Late years have seen some advance along this line.

References to Tables 5 and 6–S, and especially the latter, will bear out the statements previously made that new water-works construction will in the future be largely confined to small towns. Table 5–S shows by groups of states the size of towns supplied with water at the close of 1880, and also those supplied or about to be supplied July 1, 1891. Table 6–S shows the prospects for construction in the near future, the figures being for states and groups of states. In Table 5–S duplicate works are deducted, and the figures given are the number of cities having works, but do not include the number of outside towns supplied.

For convenience the total number of works existing in towns of various populations in the entire United States, with the corresponding percentages, are arranged in a different form below, as follows:

Number of works in towns with population.	Number. 1880.	Number. 1891.	Per cent. 1880.	Per cent. 1891.
Above 20,000	96	164	16	8
10,001 to 20,000	89	188	15	9
5,001 to 21,000	110	322	18	16
3,001 to 5,000	111	339	19	19
1,001 to 3,000	139	649	24	32
1 to 1,000	35	199	6	9
Unknown	10	147	2	7
Total	590	2,008	100	100

From the above it will be seen that in both 1880 and 1891, towns of from 1,000 to 3,000 had the greatest number of works, the totals being 139 and 649, or 24 and 32 per cent., respectively, of the totals for each period. The number of towns of this size supplied in 1891 was greater than the total of all sizes supplied in 1880, the actual numbers being 649 and 590. Down to towns above 5,000 the percentages decrease from 1880 to 1891. In towns from 3,001 to 5,000 the percentages are the same in both periods, while they increase, as we have seen, in the next class and yet again in the next. Of the large number of 1891 works for which the 1890 census was not given, nearly all are known to be in small towns, most of which are below 3,000. A classification of all towns above the several sizes gives the following:

Number of works in *all* towns with population.	Number. 1880.	Number. 1891.	Per cent. 1880.	Per cent. 1891.
Above 20,000	96	164	16	8
" 10,000	185	352	31	17
" 5,000	295	674	49	33
" 3,000	406	1,013	68	52
" 1,000	545	1,062	92	84
1,000 or below	550	1,861	98	93
Unknown	590	2,008	100	100

The details for the several groups and for Canada may be seen by referring to Table 5–S.

Table 6–S., as has been stated, relates to projected works, of which there are 348 in the United States and 15 in Canada, or a total of 363, against 265 in the second and 159 in the first issue of the MANUAL OF AMERICAN WATER-WORKS. This increase in projected works from year to year is largely due to better facilities for getting track of the projects, and partly to a less rigid classification in the present record, but few works having been classed as "indefinite" this year, it seeming better to present briefly the facts regarding each project, unless the scheme had entirely fallen through.

The total population in the towns reporting projects is 613,673 for the United States and Canada, against 646,910 in the last Manual, but the latter figures were all estimated and were known to be too high.

The Middle group has the most projects, 73, and the Pacific the least, 21. While the ownerships, as projected, are necessarily very indefinite, they are included in the table for each state, as of some interest. The totals for the United States were 132 public and 175 private, with 41 undecided or unknown. In Canada 13 public and 2 private works are projected.

The populations for projected works are estimated in some cases, the 1890 census populations not being available for some of the smaller towns, or these latter not being separately returned. The classification of projected works by size of towns for each group and for the United States and Canada is as follows:

	Above 5,000.	3,001 to 5,000.	1,001 to 3,000.	125 to 1,000.	Unknown or included.*	Total
N. E.	0	10	15	5	1	31
Mid	1	3	38	28	3	73
S. Atl.	2	9	18	15	2	46
S. Cent.	0	6	22	11	3	42
N. Cent.	1	13	22	4	..	40
N. W.	0	1	25	19	..	45
S. W.	1	7	21	18	3	50
Pac.	1	0	6	13	1	21
U. S.	6	49	167	113	13	348
Canada.	1	1	5	..	8	15

*"Included" designates towns already supplied, the populations of which are included under completed works.

From the above it will be seen that 113 projects are in towns of less than 1,000 and 167 in towns of 1,000 to 3,000, or 280 out of 348 in towns below 3,000. In towns with a population of between 3,000 and 5,000 there are but 49 projects for the whole United States and one in Canada. The number of projects in places with a population of above 5,000 is but six in the United States and one in Canada, the former projects being in the following cities, which severally have the populations given: Key West, Fla., 18,000 (estimated); Steelton, Pa., 9,250; New Berne, N. C., 7,843; Noblesville, Ind., 5,274; Helena, Ark., 5,189; Provo City, Utah, 5,159. The Canadian project is at Dartmouth, N. S., the population of which is 6,249.

The small size of the towns where the projected works are located substantiates what has already been said regarding the field for future water-works construction. Unfortunately the results of the last census are not wholly available; but if they were, a list of towns above 5,000 still without works would be seen to be a small one, while many of the towns of from 1,000 to 5,000, and several smaller ones, would be shown to be covered by the projects included above.

TABLE 5–S.

UNITED STATES AND CANADIAN WATER-WORKS.—SUMMARY BY POPULATIONS OF TOWNS HAVING WORKS COMPLETED AT THE CLOSE OF 1880 AND HAVING WORKS COMPLETED OR UNDER CONSTRUCTION JULY 1, 1891, BY GROUPS OF STATES.

	Above 20,000. '80.	'90.	10,001 to 20,000. '80.	'90.	5,001 to 10,000. '80.	'90.	3,001 to 5,000. '80.	'90.	1,001 to 3,000. '80.	'90.	1 to 1,000. '80.	'90.	Unknown. '80.	'90.	Total. '80.	'90.
New England	19	30	28	37	24	60	30	65	18	59	3	7	1	29	123	287
Middle	31	45	20	44	46	75	35	79	54	166	14	35	6	46	206	490
So. Atlantic	8	9	3	13	5	18	3	21	3	32	1	4	..	8	23	105
So. Central	7	13	3	7	5	12	5	16	1	15	..	3	..	3	21	69
No. Central	17	32	19	53	20	93	20	64	23	116	4	27	..	12	103	397
No. Western	5	13	5	17	5	30	3	45	4	128	2	61	..	7	24	301
So. Western	5	12	6	10	3	27	4	22	4	63	1	19	..	18	23	171
Pacific	4	10	5	7	2	7	11	27	32	70	10	43	3	24	67	188
United States.	96	164	89	188	110	322	111	339	139	649	35	199	10	147	590	2,008
Canada.	8	10	1	10	10	21	6	19	4	23	1	2	..	10	30	85

TABLE 6–S.

UNITED STATES AND CANADIAN WATER-WORKS.—SUMMARY BY STATES AND GROUPS OF STATES OF WORKS PROJECTED WITH FAIR PROSPECTS OF CONSTRUCTION.

	Population, 1890.	Number of Projects.—Total.	Pub.	Co.	Unk.
Me.	10,213	6	..	6	..
N. H.	19,159	8	2	6	1
Vt.	6,930	4	1	3	..
Mass.	19,197	7	3	3	1
R. I.	1,700	2	..	1	1
Conn.	14,031	4	..	2	2
Total N. E.	71,230	31	5	21	5

N. Y.	51,620	34	12	18	4
N. J.	6,473	7	..	5	2
Pa.	46,590	31	2	26	3
Del.	1,226	1	1	..	..
Md.	.....	..	..	..	..
D. C.	.....	..	..	..	..
Total Mid.	105,909	73	15	49	9
Va.	8,235	6	..	6	..
W. Va.	9,578	6	2	3	1
N. C.	16,792	6	1	3	2
S. C.	14,269	5	2	3	..
Ga.	25,109	16	9	7	..
Fla.	27,390	7	2	5	..
Total S. Atl.	101,373	46	16	27	3
Ala.	19,925	16	7	7	2
Miss.	8,349	4	4	..	..
La.	6,634	2	1	..	1
Tenn.	15,986	11	1	9	1
Ky.	18,259	9	3	6	..
Total S. Cent.	69,153	42	16	22	4
O.	35,322	12	7	3	2
Ind.	21,372	8	4	3	1
Mich.	18,266	11	8	1	2
Ill.	10,822	4	3	1	..
Wis.	10,267	5	3	2	..
Total N. Cent.	96,049	40	25	10	5
Ia.	21,485	16	11	4	1
Minn.	12,291	10	10	..	..
Kan.	.....	..	..	..	..
Neb.	11,611	11	7	1	3
So. Dak.	2,665	3	1	1	1
No. Dak.	.....	..	..	..	..
Wyo.	1,069	2	1	1	..
Mont.	2,453	3	..	2	1
Total N. W.	51,572	45	30	9	6
Mo.	14,302	6	3	3	..
Ark.	12,991	5	1	2	2
Tex.	35,225	26	7	16	3
Ok.	6,339	2	1	1	..
Colo.	4,914	10	6	2	2
N. M.	1,208	1	..	..	1
Total S. W.	75,577	50	18	24	8
Wash.	7,940	8	4	4	..
Ore.	2,874	6	1	5	..
Cal.	2,632	3	..	3	..
Ariz.	1,775	1	..	1	..
Nev.	.....	..	..	..	..
U.	9,248	3	2	..	1
Ida.	.....	..	..	..	..
Total Pac.	24,467	21	7	13	1
Total U. S.	595,331	348	132	175	41
Canada.	18,342	15	13	2	..
Total U. S. and Canada.	613,673	363	145	177	41

CORRESPONDENCE.

Free Instruction, University of Minnesota.

MINNEAPOLIS, Dec. 3, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: On page 18 of your paper of Nov. 28 I find a statement or claim that Leland University is the only institution in this country where engineering instruction is free. The University of Minnesota has courses in civil, mechanical and electrical engineering and requires no tuition fee.

WM. A. PIKE,
Dean of the College of Mechanic Arts, Univ. of Minn.

Large Siphons.

SCOTTDALE, Pa., Dec. 7, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In answer to the inquiry of Mr. T. G. DABNEY, regarding large siphons, in ENGINEERING NEWS of Nov. 28, I send the following notes of one designed and built by Mr. G. W. PEARSONS for the Quindaro water supply for Kansas City:

Diameter, 42 in.; length, 730 ft.; rise of siphon, 10 ft.; available slope, 1⅜.; capacity, about 50,000,000 galls. per day.

This siphon is of ordinary cast iron pipe with lead joints. The air which collects at the summit is removed by the use of a steam ejector a few minutes each day. This is the largest siphon, both as to diameter and capacity, of which the writer has knowledge.

KENNETH ALLEN.

The Indianapolis Cattle Guard Tests.

CHICAGO, Dec. 2, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In view of the questions of veracity involved in recent issues of the ENGINEERING NEWS concerning the cattle guard tests conducted at Indianapolis, Nov. 13, the National Surface Cattle Guard Co. would respectfully refer all parties interested, to A. G. WELLS, Esq., Superintendent of the "Big Four," under whose direction the tests made were ordered and conducted.

We have not the slightest doubt but that Mr. WELLS' report will verify the statement of results made by us in a communication to your valuable paper, dated Nov. 3, which appeared in your issue of Nov. 14.

It was never expected or even attempted by this company to construct a cattle guard which cattle would not attempt to cross, and in statements published by us, five or six weeks prior to the date of tests above referred to, our consulting engineer distinctly stated that the National guard was purposely constructed so that a famished animal persisting in its attempts to cross might succeed in doing so, as being less dangerous than a form of construction which would entrap the animal to its own destruction and almost certain injury to train.

The long interval of time which elapsed before an attempt to cross was made, and the behavior of the cattle when they attempted to cross the National guard, convinces us that our efforts in the development of a guard which would pain without injuring, and deter without entrapping roving cattle, have resulted in a marked measure of success. The tests have fully vindicated the correctness of our observations and judgments, which we had been able to form through the kindly criticisms and suggestions of the many trackmen scattered over the country, who have our cattle guards in use. It will be our earnest endeavor in the future as in the past, to perfect the National surface guard on such lines as the requirements of actual experience may suggest to us through those having charge of the fencing and track devices of our lines.

THE NATIONAL SURFACE GUARD CO.

The Fastest Train in the World.

LONDON, Eng., Dec. 1, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your issue of Nov. 21 your correspondent "L" states that there is an express which runs from Berlin to Hamburg, 177.77 miles in 3 h. 24 m. I presume he refers to the train leaving Berlin (Lehrter station) at 7:13 P. M., due at Wittenberge, 78¼ miles, at 8:43, leaving there at 8:48, and arriving at Hamburg, 177 miles, at 10:37. "L" is probably unaware that the time of arrival is "local" and that about 15 minutes must be added to the 3 h. 24 m. for the actual running time.

In Germany all the large towns have their own time and the arrivals and departures of trains are according to this, consequently the schedules do not give the actual time on journey. I have just returned from Germany and found on inquiry that the above train takes 3 h. 38 or 39 m.

In proof of this an examination of Bradshaw's "Continental Railway Guide" shows all trains running in a westerly direction to be much faster than trains running easterly between the same towns. The schedule times of best trains from Berlin to Hamburg are 3 h. 50 m., 3 h. 45 m., 3 h. 24 m. and 3 h. 37 m., while those from Hamburg to Berlin are 4 h. 15 m., 4 h. 10 m., 4h. 15 m. and 3 h. 52 m., respectively.

The speed of the best train is 48.7 miles an hour, including the one stop of 5 m. at Wittenberge, or excluding the stop 49.8 miles.

The London & Northwestern Ry. 12:23 P. M. train from Carlisle to Preston performs the journey of 90¼ miles in 1 h. 42 m., a speed slightly over 53 miles an hour. As Carlisle and Preston are each about 30 ft. above sea level, and as the line goes over Shap Fell, nearly 1,000 ft. above the sea, the performance is very creditable.

WILLIAM B. BRYAN.

[Our correspondent's information, if correct as to the exact difference of local time, as it appears to be, is directly to the point. It reduces the speed of the German train in question from 52.28 to 48.70 miles per hour, the speed of the Empire State train being 50.72 miles per hour, including stops, 52.12 miles excluding them. Such runs as that quoted between Carlisle and Preston, 90¼ miles, while very good, are not in the comparison. For much more than 90 miles of its 440-mile run the Empire State train makes over 53 miles per hour.—ED. ENG. NEWS.]

The Berliner Telephone Patent.

WASHINGTON, D. C., Dec. 2, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Your comments on the Berliner telephone patent, in your issue of Nov. 28, have attracted considerable attention here. It is a proper case to comment on and the comments should lead to some reformation of the patent statutes. You will agree with me, however, that the comments should be upon the facts which the case presents, and all of the facts which the record of the case discloses have been open to the public since the issue of the patent, Nov. 17, 1891. You say:

> That it should be possible to keep two applications, owned by the same company, in nominal interference 14 years " " is an abuse.

In saying this you doubtless refer to the interference between the Berliner and Edison applications. The examiner's letter of Oct. 29, 1891, says:

> It will be proper to state that the record clearly indicates that certainly since 1886, and possibly since 1882, this interference (Edison's) has had nothing to do with the delay in the issue of this application.

BERLINER'S record shows that his application has been in seven different interferences, and that EDISON was a party to only three of them. The examiner's letter, already referred to, says, near the end:

> This application has been pending for 14 years. The delay in this prosecution for the first four years was due to the number of interferences in which it was involved, the rule at that time requiring an interference between applications which disclosed the same subject matter, even though their claims did not conflict. This rule has since been changed, and few, if any, of these interferences would have been declared at the present date. The office delay from Oct. 23, 1883, to Nov. 16, 1888, should not, so far as the records are known to me, have occurred; such delays would certainly not occur under the present practice of the office. Since March 6, 1888, the prosecution of this application and of the interfering application upon which the issue of this application depended (DRAWBAUGH'S) has been prompt and vigorous.

The delay of five years thus referred to was a delay made by the action of the office and not by the action of the applicant. You suggest that the life of a patent should be limited "to 19 or 20 years from the filing of the application." Possibly that is the best thing to be done. The present Commissioner, Mr. SIMONDS, was a member of the last House of Representatives and a member of the Committee on Patents. He introduced and reported favorably from that Committee House Bill No. 10,637, for amending the patent law, Section 3 of which refers to Section 4,894 of the existing statute, which is as follows:

> Sec. 4,894. All applications for patents shall be completed and prepared for examination within two years after the filing of the application, and in default thereof, or upon failure of the applicant to prosecute the same within two years after any action therein, of which notice shall have been given to the applicant, they shall be regarded as abandoned by the parties thereto, unless it be shown to the satisfaction of the Commissioner of Patents that such delay was unavoidable.

Mr. SIMONDS' bill proposed to substitute the words "one year" for "two years" wherever they occur in this section. The patent committee was practically reached but once for business purposes during the whole of the last Congress, and on that one occasion Mr. SIMONDS availed himself of the opportunity to pass the International Copyright Bill. If that committee had been reached twice, there is good reason for thinking that bill No. 10,637 would now be a law. It is no secret that he will endeavor to have the coming Congress amend Section 4,894 of the statute so as to substitute six months for the two years. He has already taken steps to interest Senators and Congressmen in the matter.

J. E. WATKINS,
Secretary Am. Ass'n of Inventors and Manufacturers.

[The Patent Office is naturally endeavoring to put its best foot forward in regard to this notorious case; but whether the record, which is now at last open to the public, shows that the interferences were all with one other application or with several successive ones, it is not less morally certain that the delay was from the beginning an intentional one, manipulated by the parties in interest in defiance of the spirit and intent of the law. The amendment suggested in the last part of this letter, while proper enough, would do no real good. It is but little more trouble to write a letter once in six months than once in two years; and so long as some amendment or other office action is asked for as often as this, the application remains alive indefinitely. The Berliner case is exceptional only in the degree of its enormity. It is the daily practice of all competent patent attorneys to keep alive patents which the parties in interest are not quite ready to have go to issue by bogus procedures of this kind, often of the most trivial character, as by asking to add obviously inadmissible and improper claims. Hundreds of such cases are at all times on the files of the office. The only real remedy, and one we hold which involves no hardships, is to stipulate by law that patents shall expire either 17 years after issue *or* 19 or 20 years after the filing of *any part* of the application. This might give a few much litigated patents a somewhat shorter term. It is but just that it should. It would prevent illicit extension of the term of any patent, as it certainly should.—ED. ENG. NEWS.]

THE BROOKLYN BRIDGE, according to the annual report issued this week, carried in the year ending with Nov. 30, 1891, 39,766,043 railway passengers, against 37,676,411 the year before, an increase of 2,089,632, or only 4.9%, the only reason for this small increase being that the facilities have not been increased. Litigation and legal difficulties are alleged to be impeding the execution of the plans adopted over a year ago, by which it is hoped to more than double the present capacity. Therefore the fulfillment of our prediction that these plans when put in operation will afford no relief and but trifling increase of capacity is not yet possible. It is a question of fact which we shall watch with interest, and from which of course there can be no escape.

The Drainage of the City of Mexico.

The following is a substantially complete reprint of a paper by Mr. ROBERTO GAYOL, City Engineer, and Engineer to the Consejo de Salubridad of the City of Mexico, on the great pending improvements in the drainage of that city. The paper was one read at the last meeting of the American Public Health Association at Kansas City, and is in effect an abridgment of a much longer and more elaborate report in Spanish covering all the details of these interesting works.

The works consist in substance of two great divisions, first, the interior works necessary to drain the city proper and collect its sewage and raifall at one point (illustrated in part by our inset of last week), and, secondly, of a long canal and tunnel to drain the great valley itself in which the city lies, as more fully explained in the paper, as follows:

GENERAL TOPOGRAPHY AND HYDROGRAPHY OF THE DISTRICT.

The City of Mexico is situated in the bottom of the valley of the same name, enclosed on all sides by mountains which are of great altitude on the eastern, southern and western sides, but on the north the range presents a great depression which at points only rises to an elevation of 250 ft. above the mean level of the city. This valley contains three natural lakes, namely: Chalco, Xochimilco and Texcoco, and three artificial lakes, called San Cristobal, Xaltocan and Zumpango. A small part of this valley only is shown in Fig. 1.

Lake Texcoco is the lowest in level, the most extensive and the one that receives the refuse of the city, besides a very large share of the rain waters falling within the watershed. Its waters are strongly impregnated with salts, among which carbonate of soda predominates, as the mountains surrounding the valley contain a great deal of feldspar. These salts keep the water of the lake in a healthy condition, although for several centuries it has continuously received the refuse of hundreds of thousands of human beings.

The bottom of the lake has naturally risen in the course of years, and at present it is only 6 ft. below the mean level of the city. This difference of level was the only means of giving a current to the sewage of the city, but it notably decreased not only with the rising of the bottom, but also with the rising of the water from heavy rains; often causing a general inundation of the streets of the city.

To remedy these evils the main drainage works were projected many years ago, and their location can be seen in the general map of the valley, Fig. 1. This project includes the opening of a canal 30 miles in length and of a tunnel 6 miles in length, but their execution was for many years delayed by political disturbances and want of

FIG. 2. PROPOSED PLAN FOR THE DRAINAGE OF THE CITY OF MEXICO. Roberto Gayol, City Engineer.

money. The work is now being actively pushed forward and with such activity that the monthly extraction of earth from the canal amounts to 300,000 cu. yds., while the tunnel is pushed forward at the rate of 600 lin. ft. of finished work per month. These figures will increase in the near future, and taking into account the work already done and what is before us, there is no doubt that within 30 months more or less the waters of Lake Texcoco will be drained off, thus freeing the capital of the republic from a danger that has threatened it for many years. The salts also, which for thousands of years have been accumulating, will be carried to one point, the mouth of the tunnel, which is situated at an elevation of 7,310 ft. above the sea level.

From the very magnitude of these works their execution is necessarily slow, and to be able to facilitate the removal of sewage and storm waters with rapidity I established, three years ago, 4 centrifugal pumps with a lifting power of 76,000 galls of water per minute to 6 ft. elevation, at the same time isolating the site of the city by means of a dike of circumvallation that impedes the entrance of waters from the outside.

I established these pumps in such a way that by their means it would be possible to lower the waters in the interior of the city to the same depth to which they would fall with the general drainage of the valley, and this circumstance allows us to commence the construction of a net of sewers on a definite plan and in accordance with the principles of modern sanitary science.

In order to commence this construction it has been necessary to study a general plan in all its details, and this study may be thus outlined from a report which I presented to the City Council of Mexico City.

SYSTEM TO BE ADOPTED.

In order to determine on the best system to be adopted for the sanitation of the city, I made a careful comparative study of all the known systems and of the circumstances under which they are generally applied, as well as of the condition of our own capital so as to be able to see which under the circumstances would be the most applicable. Space will not allow me to enter into all the considerations involved and I limit myself to a description of the system determined on, which is called the Water Carriage Combined System. The conditions which make its use desirable are as follows:

Fig. 1.

1st. When it is necessary to drain off by means of sewers a large quantity of storm waters, and it is therefore necessary to construct a new system of sewers with this object.

2d. When it is not necessary to purify the sewage, or when at any rate, its purification would be an easy matter, and it would not contaminate the supply of drinking water.

3d. When an abundance of water is available to flush the sewers.

The first condition fully obtains in Mexico, as it is an extensive, densely populated city, and it is absolutely indispensable to construct new sewers to give an outlet to the sewage and the storm water, as neither one or the other can be allowed to run on the surface of the streets, because, besides the many inconveniences of such a system, there is not enough fall on the surface to produce the necessary movement of the fluid. Besides this, the pumps which I established have produced such changes in the hydrography of the city (which changes will be continued and made permanent by the general drainage of the valley) that it is necessary to reconstruct the whole system of sewerage, and destroy the existing sewers, which are very defective and cannot possibly be brought into the new system.

The second condition is also realized, as the sewage at present goes to Lake Texcoco without any inconvenience and later on will go to the other side of the valley to the outlet before mentioned at an elevation of 7,000 ft. above the sea; and the purification will be made by the intermittent filtration of the sewage, which will be utilized in the irrigation of the immense extension of farming lands below the mouth of the tunnel, covering several thousands of square miles. Neither is there any drinking water to be contaminated, as the current which it is proposed to create does not at present exist.

The third condition can be realized in Mexico in so complete a manner, that doubtless there are very few cities in the world that have such good facilities for flushing sewers. For this object we can count on the water in the lakes of Chalco and Xochimilco already mentioned, which can supply during the whole year 35,000 galls. of water per minute. This water is not drinkable, but it can be very well used for flushing the sewers, and can be conducted to the highest point of the drainage system.

These conditions are general and applicable to any city but we have in Mexico another worth considering, which is, that now as well as in the future the storm waters and sewage must mix, whether in the lake of Texcoco or in the drainage canal now in construction; and it is not worth while to undertake any work to separate elements which eventually must mix, nor ought any sacrifice to be made with that object.

It is, therefore, clear that in Mexico an excellent application can be made of the combined system, while there is not one single reason for the establishment of the separate system or any other. There is no doubt possible on the subject and from this I came to the following conclusion:

To obtain in Mexico the most advantageous sanitary system at the lowest possible cost, THE WATER CARRIAGE COMBINED SYSTEM *ought to be established; that is to say, that the sewers or conduits must be conveniently arranged to receive the liquid refuse of the houses, the house sewage, the storm waters wherever necessary, the subsoil water, and, finally, the refuse liquids from industrial establishments.*

TOPOGRAPHY OF THE CITY.

The general plan of the City of Mexico, Fig. 2 shows the contour lines at 20 cm. apart (about 8 ins.). The contours show that there are several places where the ground is lower than the general average, and that the differences of level are hardly perceptible; that there is a slight fall from west to east, and that there is no *talweg* or natural line of drainage.

These special conditions show that it is impossible that the liquids should run on the surface of the ground and that it is necessary to construct sewers to receive them: that it is also necessary to give these sewers the fall which they require, increasing the difference of level by artificial means, whether by pumps as at present or by the drainage works of the valley; that this fall must be established from west to east, and that the arrangement of the sewers on the plan must be fixed by considerations independent of the topography, as this does not oblige us to establish the main sewers precisely on any determined line.

ALINEMENT OF THE SEWERS.

The last circumstance referred to in the preceding paragraph will allow of a great many different combinations, whose advantages and disadvantages I have carefully studied and compared.

We could, for instance, at once determine on concentrating the whole of the sewage in one single main running through the center of the city, but this main would require to be of an enormous size at its lower end, thereby greatly increasing the cost of construction and the difficulties incident to its passing through many narrow streets; beside which, during the rains the water would rise within the sewer, very much decreasing the hydraulic grade and, consequently, its discharging capacity. And lastly, it would increase the importance of the lateral sewers, diminish their fall and also increase the difficulty of cleaning out the whole system:

For these reasons I have found it more convenient to divide the city into five districts by means of lines whose general direction is east and west. On the central longitudinal line I propose a main sewer, and on the division line between each two districts I would have another sewer which would at the same time receive the sewage and distribute the water for flushing the lateral and main sewers; and to these sewers I have given the name of "distribution sewers." Branching off from these there will be other sewers of small section, called the lateral sewers.

In the arrangement of these sewers I strictly followed LINDLEY'S principle, avoiding by all means *dead ends*, in order that every point in the system should be reached by an abundance of water which would clean the sewers and carry off any deposit. In the construction of these sewers I also strongly recommend the principles laid down by RAWLINSON.

In the general plan of the city (Fig. 2) I show the arrangement of all these sewers as well as their rate of grade, their section by diameter in centimeters and their length in meters between their points of junction or bifurcation. The following table shows approximately the total length of sewers required for the complete drainage of the city, about one-fifth of this length being required for the drainage of the central and most thickly settled district in greatest need of immediate improvement:

0.40 m. sewer pipe	56,068	Type 2, brick sewer	2,933
0.45 " " "	48,867	1.25 diam. brick sewer	2,815
0.53 " " "	36,368	1.50 " " "	6,376
0.55 " " "	25,161	1.75 " " "	9,661
0.60 " " "	49,508	2.00 " " "	7,860
Type 5, brick sewer	6,116	2.25 " " "	734
" 1, " "	3,307	2.50 " " "	278
" 3, " "	4,692	3.00 " " "	1,149

DEPTH AND FALL OF SEWERS.

The level of the lateral sewers is established by the fact that the system of flushing requires that the water shall reach them through the distribution sewers, passing thence through them and then discharging into the main sewer. The lateral sewers thus form an artificial *talweg* through which the waters of each district would have to flow, and for this reason it is clear that the distribution sewers ought to be placed at the highest level on corresponding points in a north and south direction.

The general fall of the whole system of drainage is naturally established as from west to east, being so prescribed by the circumstance that the natural fall of the ground is in that direction.

The depth at which the sewers will be built at their eastern extremity, which is also the lowest, is determined by the level to which the waters will be reduced by the general drainage of the valley; and this level will be 3 m. (about 10 ft.) above datum, while their western extremity is fixed by the highest altitude at which their commencement can be placed, bearing in mind the altitude of the ground. The latter varies from 9 m. to 10 m. above datum (30 to 33 ft.), while the inverts will have to be placed in such a position that there will be only 18 ins. of earth over them. Dividing this difference of level by the length I obtain the very reasonable grades which are shown on the plan.

(To be continued.)

The United States Navy of 1891.

The annual report of the Secretary of the Navy has been submitted to the President, and in it Mr. TRACY outlines the marked progress we have already made in creating a new navy. During 1891 four new vessels have been placed in commission, making a total of 13 since March 4, 1889. As a matter of convenient record we reprint the list of these ships from the report, as follows:

Name.	Displacement, Tons.	Commissioned.
Chicago	4,500	April 17, 1889
Yorktown	1,700	April 23, 1889
Petrel	870	Dec. 10, 1889
Charleston	3,730	Dec. 26, 1889
Baltimore	4,400	Jan. 7, 1890
Cushing	99	April 22, 1890
Vesuvius	970	June 7, 1890
Philadelphia	4,300	July 28, 1890
San Francisco	4,083	Nov. 15, 1891
Newark	4 083	Feb. 2, 1890
Concord	1,700	Feb. 14, 1891
Bennington	1,700	June 29, 1891
Miantonomoh	3,815	Oct. 27, 1891

In addition to these, twenty-three other war-ships are now under construction, authorized under acts of Congress for 1886-91, and are all making rapid and substantial progress toward completion. Of these vessels the coast-line battleships, *Indiana*, *Massachusetts*, and *Oregon*, of 8,500 tons each, and with 17 ins. of armor, are to be finished in November, 1893. The armored cruiser, *New York*, of 8,150 tons, is launched, and can be finished in 9 months. The protected cruiser No. 12, of 7,400 tons displacement, 21,000 I. H. P., and 22 knots speed, is to be finished in 1893. Protected cruiser No. 6, of 5,500 tons displacement and 20¼ knots speed, is to be completed by Jan. 1, 1893. The harbor-defense ram, now building at the Bath Iron Works, of 2,100 tons, is to be finished in June, 1892. The armored cruiser, *Maine*, 6,648 tons, was launched at New York, on Nov. 18,1890; and the coast defense ship, *Monterey*, was launched at San Francisco, on April 28, 1891. The monitors *Puritan*, *Amphitrite*, *Monadnock* and *Terror* are awaiting their armor and guns, and the same may be said of the armored cruisers *Maine* and *Texas*. The cruisers *Cincinnati* and *Raleigh*, and Nos. 8, 9, 11, and gunboats Nos. 5 and 6 are all well under way. The cruiser, *Detroit* (No. 10) was launched at Baltimore on Oct. 28 last, and Nos. 9 and 11 will probably be launched this year. The *Cincinnati* and *Raleigh* will be ready for service early in 1893.

As noted above, the most momentous question to be considered by the Department is that of armor. The first consideration was that of selection, and Mr. TRACY says that the late trials of armor plate show that the high-carbon, nickel Harveyed plate is undoubtedly the best armor-plate ever subjected to ballistic test. These trials also show that armor of excellent quality can be produced by the rolling process, and that expensive forging by the hammer is no longer an absolute necessity. The importance of this discovery lies in the fact that within a year or two the armor-producing capacity of the United States can probably be quadrupled in case of necessity, and that a lump-contract of 10,000 tons given with 18 months time would mean a reduction in cost of from 25 to 33%, as the work, hitherto confined to two firms, would be thrown open to a number of competitors.

The number of guns required to arm vessels now

authorized and the status of work upon them are given in the following table:

	Number of guns required to arm vessels provided for by law.	Number of sets of forgings ordered.	Number of sets of forgings delivered.	Number of guns completed.
4-in.....	69	35	35	7
5-in.....	56	29	29	2
6-in.....	129	134	134	117
8-in.....	51	51	30	19
10-in.....	22	25	14	8
12-in.....	8	8	4	1
13-in.....	12	12	0	0
Total.....	347	294	246	155

Among the later guns is a 6-in. of 40 calibers which has been very satisfactorily tested. The manufacture of 8-in. guns is ahead of the immediate demand for them, and two 8-in. guns of 40 calibers and exceptionally high range have been contracted for and will form part of the batteries of the "commerce destroyers," cruisers Nos. 12 and 13. For the secondary batteries 150 Hotchkiss guns have been completed, and 50-6 pdrs. of increased length have been ordered, together with 25-1 pdrs. of the latest type The Driggs-Schroeder 6-pdr. has been most successfully tested and a further order has been given for 75 of these guns.

The most important advance in the direction of powder made in the year is the smokeless powder of Prof. C. E. MUNROE, of the Naval Torpedo Station. It has been used successfully in the 1, 3 and 6-pdr. guns and the 4-in rapid-fire guns. The tests with a 3-pdr. rapid-fire gun show a muzzle velocity of 2,250 ft. per second with a chamber pressure of 14.8 tons, and in the 6-pdr. Hotchkiss gun a velocity of 1,920 ft. is secured with 14.3 tons pressure. It has all the good qualities of smokeless powder of foreign make, and exceeds them in uniformity of composition and permanence in storage. It is unaffected by repeated heating for long periods, is uninjured even by boiling in water, and gives high and uniform velocities. The Duponts, of Wilmington, Del., as the result of a contract for 50,000 lbs. of gun cotton, are now erecting a plant at their works with a capacity of 1,000 lbs. per day of this explosive. Emmensite, for exploding shells, has been favorably reported upon by the naval authorities, and is regarded as a high explosive which is as powerful as gun-cotton and can yet be detonated with a less sensitive fuse than the fulminate fuse used with the latter.

Until this year the United States was without armor-piercing projectiles of American manufacture. But under a late contract all the 6-in. and one-half of the 8-in. projectiles of this description have now been delivered and tested. The Carpenter Steel Co., the contractors for these projectiles, have distinctly improved upon the foreign process used. We can now obtain in the United States all the armor-piercing projectiles we want. Forged steel shells have been contracted for for the 4, 5 and 6 in. guns, and shells electrically welded are also being made by a new process by the American Projectile Co., of Boston.

While the navy was lately absolutely without torpedoes, a contract was made in May, 1891, for 100 18-in. Whitehead torpedoes, and if the tests be successful, as expected, they can be furnished at the rate of 100 per month. The Secretary believes that within a short period the torpedo equipment of our navy may soon equal, if not surpass, that of other nations.

In connection with the increase of our navy, Secretary TRACY says that the old wooden ships of our navy have practically passed out of existence and our sole reliance is upon the new war-ships. He earnestly advocates continued and rapid additions to our present fleet as absolutely demanded in the interests of our commerce and for the protection of our now practically separate coast lines. He quotes the words of a former Secretary of the Navy, Hon. J. C. DOBBINS, who in 1854, spoke against an existing apathy regarding an American navy as follows: "Weakness invites aggression and never inspires respect; while acknowledged strength and visible preparation command consideration and are the true safeguards of peace." Our readers can apply this quotation for themselves to the present absurdly defiant attitude of Chili with its 3,000,000 of inhabitants. The urgent need is also pointed out of the early authorization of more ships. The progress of construction during the last eight years has clearly shown the necessity for such early action, as any authority given at the present session of Congress would hardly reach the point of effectual commencement of work until the spring of 1893, when the vessels now authorized would be practically completed. The preliminary work of passage of act, selection of design, plan, contract, &., for each large ship usually consumes about 18 months. We cannot now afford to stop our navy building.

As to the type of warship recommended for further protection, the Secretary favors the *Indiana* class which has a main battery capable of delivering at one discharge 6,800 lbs. in weight of projectile, with an energy of 210,000 foot-tons. And the energy of the 13-in. gun, to be placed on these ships, is sufficient to pierce 22 ins. of armor at one mile distance. The secondary battery of 16-6 pdrs. and 4-1 pdrs. will discharge 330 projectiles per minute. In addition these ships are provided with tubes for an all-around torpedo fire of 18-in. torpedoes, each carrying 250 lbs. of a powerful explosive. This type of ship can be alone relied upon to resist attack from armored war-ships of other nations and the three now building are not enough to fill the most modest requirements. The 4,500-ton cruiser is a valuable auxiliary at any time and is useful in carrying our flag about the world in time of peace; but the defensive strength of the United States can only be measured by ships of the more powerful type. Secretary TRACY urges that naval construction should continue upon the lines of these three ships now under construction, the *Indiana*, *Massachusetts* and *Oregon*. The efficiency of these vessels is beyond question, and it is better policy to build one of this type than two like the *Maine* and *Texas*, for example, of so much less comparative power and costing at least one-fifth more than the single vessel. He further recommends another large armored cruiser of the *New York* type, combining great coal endurance, high speed and efficient armor protection, together with a heavy battery of 8 in. guns, a total next to the coast-line battle ships. The Secretary considers the *New York* as "the most important element of defensive strength which this country now possesses."

The tendency of naval construction all over the world is now to build large ships; with the object of uniting high power guns, of at least 8-in. caliber, with protected sides and deck, high speed and great coal endurance. Russia now leads in this direction with the cruiser *Ruric* of 11,000 tons; England is now completing the *Blake* and the *Blenheim* of 9,000 tons, and nine cruisers of the *Edgar* class of 7,500 tons; France is building the *Dupuy de Lome* of 6,300 tons; Germany is building the cruiser "*H*" of 6,000 tons, and Spain has ordered three cruisers of 6,900 tons and one, and probably three, of 9,200 tons. The building of 3,000-ton cruisers, with moderate speed, light armor and small coal endurance, has practically ceased abroad, as the speed of a fleet is that of its slowest ship. Mr. TRACY recommends the speedy construction of torpedo cruisers of 800 to 1,000 tons displacement, with light draft, a speed of 22 knots, adequate coal capacity, rapid fire-guns and a powerful torpedo armament. Such boats have many functions and are indispensable in cases of blockade.

The following table shows the comparative situation of sixteen principal states in the matter of torpedo boats, and the position occupied by the United States in the list calls attention forcibly to the importance of providing this economical and effective means of defense:

TORPEDO BOATS BUILT, BUILDING, OR PROJECTED, 1890-91.

Nation.	*No. boats.* 1890.	1891.	*Increase Past Year.*
France	210	215	5
England	177	199	22
Germany	180	180	..
Italy	152	165	13
Russia	143	152	9
China	32	69	37
Austria	61	65	4
Greece	51	51	..
Holland	50	50	..
Denmark	34	34	..
Norway and Sweden	31	34	3
Turkey	30	32	2
Japan	24	28	4
Brazil	15	16	1
Spain	15	15	..
United States	1	2	1

The remainder of the report relates to the personnel of the new navy and the changes in law and method required by the changed naval conditions.

The Electric Lighting of Warships.

(*Concluded from page 549.*)

MM. Sautter, Harlé & Co. are constructing two 75 cm. electrically controlled projectors for the Russian ironclad *Gangoot*. The 90 cm. projectors are found to be inconveniently large for ship's use. In the 75 cm. projectors supplied the Russian navy, as well as the 60 c. m. projector, type 1891, used in the French navy, the mechanism for controlling at a distance is placed in the pedestal. The principal details of the mechanism are the same in each: A double electric motor with two armatures; suitable gearing for transmitting the movement to the turn table of the projector for producing the horizontal and vertical displacement of the beam; an automatic interrupter limiting the angular movement in both directions. The apparatus is controlled by two spring handles, one for the horizontal and the other for the vertical movement; these handles are placed at right angles to one another, and their position is such that the movements made by the hand of the operator correspond to the movements which it is desired to impart to the projector. This is similar to the modern method of pointing a gun when worked by electric motors. Pushing the handle to the right causes the beam to be deflected to the right; pushed to the left, the beam turns to the left. The mechanism is so arranged that as soon as the operator releases either of the handles it returns to the zero point and all further motion is immediately arrested. It is easy at will to obtain a definite range of speed or a series of concerted movements. A cable connects the controlling mechanism to the projector, it is made up of the requisite number of conductors, the ends of which are attached to the numbered terminals outside the case of the apparatus.

In addition to the improved controlling mechanism just described, the projectors supplied the Russian navy possess another excellent feature. One of the conditions prescribed in the specifications prepared by the Minister of the Russian Marine was that a complete occultation of the luminous beam should be produced at will and almost instantaneously. As is well known, many circumstances must arise when it becomes necessary suddenly to extinguish the lights on board the vessels, either to divert the enemy's fire, which is attracted by a permanent beam, or to produce a blinding effect by sudden extinctions and relighting of the lamps and projections of the beam, which, repeated frequently, has the effect of confusing the movements of a hostile force and greatly increasing the safety of the vessel attacked. In the system applied up to the present time, if the current feeding the lamp is cut off, extinction is not instantaneous. The carbons remain incandescent for some instants after the current ceases to flow, and they give sufficient light to mark the position of the projector. If the ray is cut off by a screen occultation is not complete; the direct rays are intercepted, but the diffused light which illuminates the edges of the apparatus continues to render it visible. This causes serious inconvenience.

Numerous experiments made in England, and especially in Russia, in firing against projectors, have shown that it is easier to direct an effective fire against them when the light is comparatively indistinct, and that it is almost impossible to estimate the range in the full brilliancy of the beam. It is for this reason that MM. Sautter & Harlé have designed the two occultating shutters placed in front of the glazed mouth of the projector and each of them covering a half circle; by this means a rapid and absolute extinction of the beam is produced. These shutters are movable around a fixed lateral hinge; they are actuated by two connecting rods parallel to the axis of the drum, and coupled by a transverse rod furnished with two handles; by pushing these in one direction the shutters are opened and by moving them in the other they are closed. By suitable mechanism these shutters can be operated at a distance, a valuable feature in this arrangement. This is effected by attaching to the back of the drum a small electric motor that controls, by means of gearing, the transverse connecting rod; the armature of this motor is actuated by a current furnished from the main cable coupled to the manipulator and inclosing eleven conductors. The connections are made direct with the terminals of the projectors, the occultating motor being joined up by means of a

flexible lead. The motor is excited by a derived current taken from the terminals of the lamp; on the same manipulator is a commutator by which the circuit of the armature can be opened or closed at will; and the movement of the shutters in either direction is almost instantaneous. As soon as these shutters reach the end of their travel they are stopped instantly by the action of an automatic interrupter which short circuits the armature.

The only precaution which it is necessary to observe is not to operate the occultating shutters when the lamp is not lighted; there would, however, be little danger of such a manœuver being performed. The form of the shutters has been designed in such a manner as to secure as complete an occultation of the beam as possible, and the greatest possible care has been taken in constructing the apparatus, that there should be *no escape of indirect light from any openings.*

MM. Sautter & Harlé have in this class of automatic projectors, preserved a simple means of replacing the control at a distance by direct hand manipulation. By pressing over a lever, the mechanism of the base is thrown out of gear and the apparatus can be moved by means of a handwheel, as in the projectors of ordinary construction. For the occultating shutters it is sufficient to shift back a sleeve that keeps the lateral connecting-rod in place and connected with the gearing of the motor; the movement in this manner becomes free. The standard sizes of projectors made by Sautter & Harlé are 30, 40, 60, 75 and 90 cm. (inside diameter of drum). The 30 cm. size is used chiefly in steam launches or other small craft.

The Italians believe in a large number of comparatively small projectors. The 40 cm. is the one in general use in the Italian navy, some vessels having as many as 14. One of these, fitted with electrical control is shown in Fig. 4.

The 60-cm. projector has until recently been the standard one for general ship's use for nearly all navies; and it is questionable if sufficient advantage can be obtained to justify the introduction of a larger size than this on board ships. Fig. 5 shows one of the two 75-cm. projectors that are being constructed to go in the tops of the Russian ironclad *Gangoot*. They are fitted with occultating shutters and electrical control at a distance.

The 90 cm. projector is used chiefly for coast defense. The lamps are automatic and carry heavy currents.

A good working current for the different sizes of naval projectors is for the

75 cm.	projector	80-90 ampères
60 "	"	50-80 "
40 "	"	35 "
30 "	"	20 "

The best voltage at the terminals of the lamps is for good working 45 to 50. Where compound dynamos are used to supply all the light and power for the ships, which is generally the case, it is customary to place a resistance in each search light lead, taking up as much as 15 or 20 volts. In this way the lights can be operated successfully in multiple from the same dynamos that feed the incandescent lamps, motors, &c.

Regarding the range, the 60-cm. projector, with the lamp taking 75 ampères and the beam concentrated, should give a range of 2 to 3 miles; that is, should make light objects plainly visible at that distance on dark nights (no fog or mist).

Fig. 6 shows type of generating set supplied by Sautter & Hallé for some of the French torpedo boats. Each of these plants will operate a number of incandescent lights together with a search light of 30 or 40 cm.

FIG. 5. MANGIN PROJECTOR WITH OCCULTATING SHUTTERS AND ELECTRICAL CONTROL AT A DISTANCE.

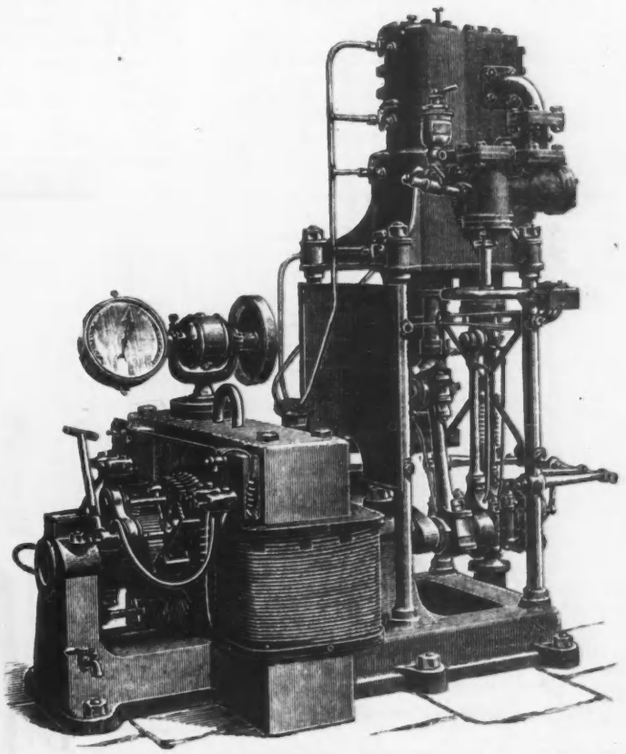


FIG. 6. TWO-CYLINDER ENGINE AND DYNAMO FOR FRENCH TORPEDO BOATS.

The focal lengths for the different-sized projectors are as follows:

	Cm.		Cm.
30 cm	.16	75 cm	.54
40 cm	.24	90 cm	.76
60 cm	.32.2		

Electric Motors.—The many well known advantages of electric motors are causing them to be preferred to the numerous small steam engines heretofore installed on board ship. In the *Capitan Prat*, one of the Chilian ironclads recently built by the Forges et Chantiers de la Méditerranés, the use of electric power has been applied to an extent hitherto unknown on board ship. Electric motors are here used in preference to hydraulic power for working the turrets containing the heaviest guns of the main battery. The rapid fire guns, or what is known as the secondary battery, of this vessel are also worked by electric motors, the advantage being that they can be pointed with rapidity and precision. Electric motors are also used to control the firing of machine guns instead of depending on another man to turn the crank. The advantage of having the same man sight and control the firing of the gun is obvious. The tendency is to utilize electricity for the firing of all guns, for with electric primers the actual firing is more nearly instantaneous with the moment that the sight is on the target. Ventilating fans and electric drills are also examples of the application of electric motors on board modern warships. In France, the opinion is held that the adaptation of electric motors to pumps, hoists and winches is only a question of time, and that little by little we shall see the complicated, inefficient and cumbersome hydraulic and steam pipes disappear from battleships.

Electric Signaling.—We will refer only to exterior signaling, as for instance between vessels, as distinguished from interior signaling between the different stations in the same vessel. For the latter purpose, voice pipes, the telephone, call bells, &c., are the principal apparatus utilized.

For signaling between vessels, the system of flags is in common use during the day and is under most conditions satisfactory. For signaling during foggy weather, whether by day or night, until something better is installed we have to revert to sound signals, generally the steam whistle. It is at the best unsatisfactary, particularly on account of the unavoidable time element, as illustrated by the long and short blasts.

The qualities to be sought in any method or device for transmitting signals of any kind between ships are simplicity, rapidity, reliability and distinctness. The requirement of rapidity is the one for which electricity is so well adapted. For long distance signaling, special apparatus is necessary in order to get distinctness, but at the expense of slowness. The general requirements of squadron signaling, however, can be met by making use of the incandescent lamp. A set of lanterns are suspended aloft, from which a multiple cable leads to the keyboard where the operator is stationed, thence to the dynamo. The lanterns contain incandescent lamps, and the different combinations are displayed by manipulating the keyboard so as to close the circuit of the lamps corresponding to the desired combinations. The same signal book answers for both day and night signaling, each combination of lamps corresponding to a flag used by day. Nearly all navies have adopted some such system as this for general squadron signaling when a moderate range only is required. The system is fairly reliable, distinct up to a range of 3 miles in

good weather, and more rapid than flag signaling by day. A very important feature of the system is the fact that each display signaled is answered by a repetition of that display. When a signal is finished it is known positively that the signal has been correctly received, and one display is then made as a signal of execution. This certainty is not attained by any system of signaling, either night or day, when a simple answering light or pennant is shown.

The number of lanterns and the colors used, vary in different systems. Red and white are the most suitable colors, and the number of lanterns will

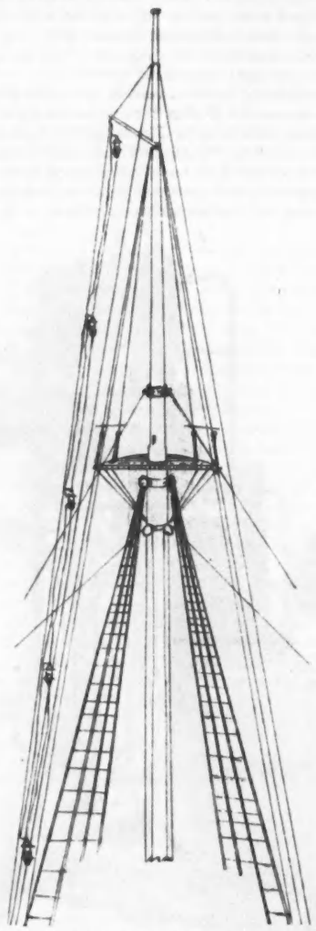


FIG. 7. ARDOIS SYSTEM OF SIGNALING.

then depend on the number of combinations required to equal those that can be obtained with the flags.

In the Ardois system, five double lanterns are used as shown in Fig. 7; each of these double lanterns containing two 32 candle incandescent lamps. The outer globe, or lens, of the lantern is in two colors, the upper half being white and the lower red, separated on the inside by a brass diaphragm. This arrangement admits of a display at any one time of from one to five lights, any one of which may be red or white. This system has been adopted in the Russian Navy and has been tried and reported upon favorably in the U. S. Navy.

Much more might be written on the numerous and varied applications of electricity on shipboard, suffice it to say, that those applications that have been touched upon in this paper are the most important ones, and have received the greatest development. When modern war vessels go into action, the captain's station is in the armored conning tower. Here he controls the entire manœuvering power of the vessel. Here, by the simple movements of a lever or switch, or the pressing of a button, he controls the engines, moves the helm, fires a broadside, launches a torpedo and works the search lights; moreover, he can at any time communicate either by speaking tube or telephone, with all the important stations in the ship; such improved means of communication being made necessary by the numerous subdivisions of compartments in the construction of modern warships.

A Straight-Way Valve for High Pressure Steam.

The advantages of straight-way valves over globe valves or other types which necessitate the diversion from a straight line of the fluid flowing in a line of pipe, have long been recognized in hydraulic work. For use with steam valves, however, globe valves, poppet valves and other types which make necessary considerable diversion of the flowing current of steam continue to be the favorites, partly because the fact is not generally appreciated that every resistance to the flow of steam between the boiler and the engine causes a loss; and manufacturers, of course, supply such material in steam fittings as their customers demand. Another reason may be the convenience of globe valves for regrinding and refitting and their smaller expense.

The Chapman Valve Mfg. Co has recently patented and put upon the market a straight-way valve for high pressure steam, for which superiority is

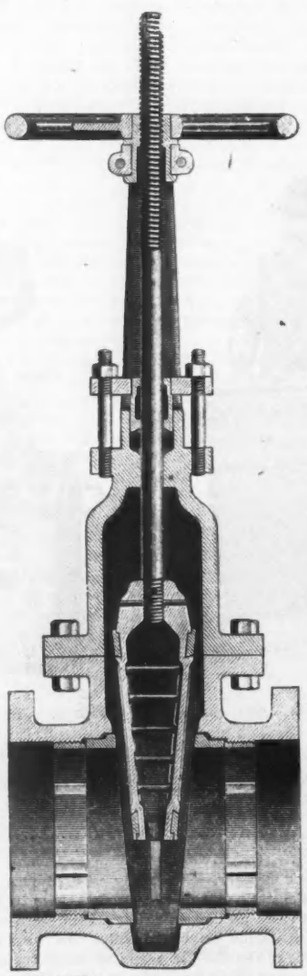


FIG. 1. STRAIGHTWAY VALVE FOR HIGH STEAM PRESSURES. CHAPMAN MFG. CO.

claimed in the important points of strength, durability, ease of manipulation and satisfactory tightness.

Fig. 1, which is a vertical section through one of these valves, shows their construction and operation. The valve seat is made of bronze and is removable and adjustable. The shell is made extra heavy to withstand the strains due to contraction and expansion. The spindle is made of either gun metal or steel. On valves 12 ins. or more in diameter a by-pass is added, as shown in Fig. 2, which relieves the pressure on the main valve when it is desired to open or close it. The main valve is raised and lowered by an outside screw and yoke, thus making the valve spindle itself an indicator whether the valve is open or shut.

The gate is made in one piece and is guided in the body of the shell by vertical ribs or splines. These take all the side strain due to the pressure on one side of the valve while it is opening or closing, until the last turn of the hand-wheel brings the gate to its seat. Wear on the seat due to opening or closing is thus reduced to a minimum. For steam, these seats are made of hard bronze, and for gas, acids, &c., of such other material as will give best service. These seats are pressed into their proper positions in the body of the shell and are held in place by means of the screw gland inserted through the pipe ends, which can be worked forward and back by a spanner, coming into contact with the ribs on the inside of the screw gland. By taking off the cap of the valve-body and removing the gate, the seats may be forced toward the center of the valve body by means of the screw gland until they are released and can then be removed and others inserted in their place if desired.

These valves are made either with inside screw or

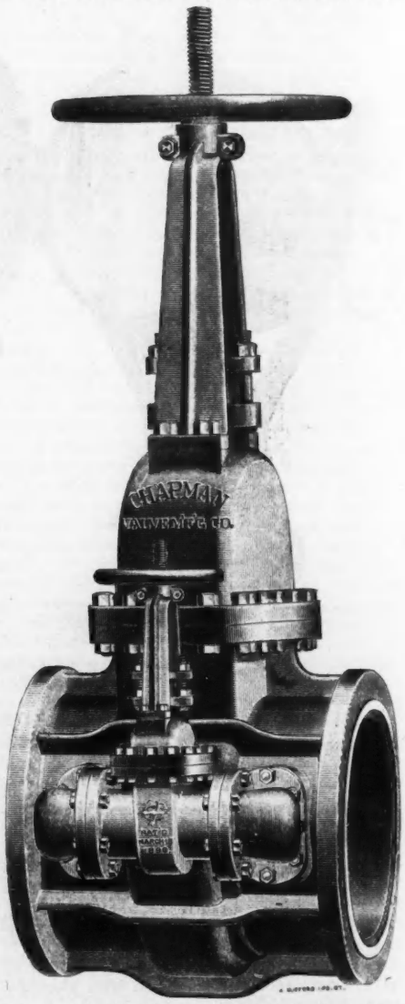


FIG. 2. LARGE SIZE STRAIGHTWAY VALVE FOR STEAM WITH BY-PASS.

outside screw and yoke, with or without lateral ribs between end flanges, with or without by-pass attachment and with or without the projecting ring on the end flanges shown in Fig. 2.

These valves have already been put in use for high pressure steam in a large number of plants. Among them are street railways in Wilmington, Atlanta, San Francisco, Brooklyn, Washington, New York City and Buffalo, the West End Co. of Boston, the

Babcock & Wilcox Co., Amoskeag Mills of Manchester, N. H., the Pennsylvania Railroad, the Field Engineering Co., the Illinois Steel Co. and electric lighting stations in Providence, New York City, Chicago and Memphis.

The Fuel Supply of the United States.

In a paper on this subject before the American Institute of Mining Engineers Mr. JOHN BIRKINBINE gives the following details:

The total output of the anthracite regions of Pennsylvania for the past 70 years approximates 750,000,000 tons. Of this over 12% was obtained in the 40 years between 1820 and 1860; 15% in the decade following; nearly 25% between 1870 and 1880, and for the past 10 years the output has averaged about 35,000,000 tons annually, aggregating nearly 48% of the whole.

An approximate review of the consumption of all kinds of fuel for the past 20 years may be obtained from the following data, taken chiefly from the census reports:

	1870.	1880.	1890.
Gross tons of anthracite coal	13,925,229	21,580,189	40,714,721
Gross tons of bituminous coal	15,356,619	38,242,641	85,383,059
Bushels of charcoal	.....	74,008,972	90,000,000*
Cords of wood	.....	145,778,137	180,000,000*
Barrels of petroleum	5,260,745	26,286,123	34,820,306
Natural gas, value in coal displaced	No report	No report	$20,000,000*
	Gross tons.		
Pig iron	1,832,876	3,375,912	8,553,374
Manufactured iron	1,287,347	2,101,183	2,518,193
Steel	44,426*a*	1,022,956*b*	3,988,327*b*

a, finished product; *b*, ingots.

The fuel consumed in the United States, exclusive of natural gas, but including the coal and wood converted into gas, is estimated to require the conveyance, by various methods, of nearly 1,569,000 gross tons each day of the year (no unimportant factor in the national problem of transportation), and to demand the energies of over 1,000,000 wage-earners to mine, cut, handle and convey it to points of consumption. The fuel consumption, *per capita*, in the United States, is in calorific value equivalent to 3½ tons of coal per annum. Possible economies may reduce this to 2½ tons for the same amount of work performed.

The Compressive Strength of Brick.

The results from carefully conducted tests, made to show the compressive strength of brick, are of interest to engineers and architects, and we print herewith a table showing results of twelve tests lately made at the Watertown Arsenal. The brick in question are known as "pressed red fronts." The special bricks tested were not particularly selected for that purpose, but were taken at random from those stored in the stockhouse, excepting as to shade of color.

The bricks, when taken from the kiln, are carefully sorted as to shade of red into twelve different shades; the lower numbers, 1, 2, 3, &c., indicating the lighter shades, while the higher numbers, 10, 11, 12 indicate the darker shades. The numbers 1 to 12 inclusive in the appended table refer to this grading.

It might be remarked in passing that these brick are made by the "dry clay process." The clay is ploughed and scraped from the bed at a dry time, an operation which breaks it up rather fine, and it is then stored under sheds for about a year to destroy all vegetable growth. It is then crushed still finer and passed through suitable riddles to separate any extraneous matter, such as chips, pebbles, &c., and comes out a fine, almost dry, powder. This is then pressed in iron molds with a heavy hydraulic pressure of about 3,000 lbs. to the sq. in. The result, even in the "green" brick, is a fine, smooth surface, and the brick is very compact, possessing some strength, considering that it is made of an almost dry clay. The green brick are ranked up in the kilns without other preparation, and are ready for "firing." The kilns are permanent structures with a closed arch top, and are fired with a down draft, using crude petroleum for fuel, vaporized by a steam jet. The heat is kept very uniform, and the result is a minimum of "wasters"; all the brick being hard burned and of a good color.

An examination of the detailed report shows in general a greater crushing strength with the higher numbers, or darker colored brick. The crushing strength varies from 94,800 lbs. per brick, to 170,500 lbs. per brick; or 2,660 lbs. per sq. in. to 4,973 lbs. per sq. in., an average of 3,792 lbs. per sq. in. The relation between the "cracking load" and the final "ultimate crushing load" varies from 68.7% to 94.7%, with an average of 81.5%.

TESTS FOR CRUSHING STRENGTH OF TWELVE "RED FRONT" BRICKS.

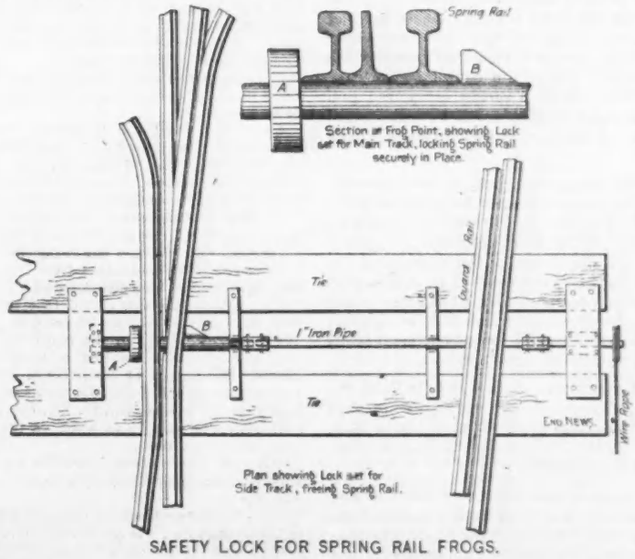
Manufactured by the Chicago Hydraulic Press Brick Co., of Porter, Indiana. Tested Nov. 6, 1891, on "Emery machine," at Watertown Arsenal, Watertown, Mass. Brick tested "on the flat." Surfaces under pressure faced with plaster of Paris.

No.	Dimensions. Height. Ins.	Length. Ins.	Width. Ins.	Area under load. Sq. ins.	Load. 1st crack. Lbs.	Ultimate crushing load. Total load. Lbs.	Lbs. p. sq. in.
1	2.38	8.50	4.13	335.10	88,000	112,100	3,194
2	2.33	8.56	4.22	36.12	69,000	100,350	2,778
3	2.36	8.56	4.16	35.61	70,500	94,800	2,660
4	2.33	8.58	4.12	35.35	71,800	95,380	2,698
5	2.37	8.62	4.04	34.82	96,000	118,100	3,391
6	2.36	8.60	4.00	34.40	91,000	115,250	3,350
7	2.25	8.48	4.20	35.62	104,000	125,800	3,531
8	2.28	8.51	3.94	33.53	136,000	162,650	4,851
9	2.32	8.33	4.12	34.32	121,000	160,900	4,688
10	2.28	8.40	4.10	34.44	156,000	168,120	4,881
11	2.25	8.36	4.10	34.28	138,000	170,500	4,973
12	2.30	8.23	4.12	33.91	145,000	152,900	4,509

Average crushing loads, 3,792 lbs. per sq. in. In all cases the crushing came from the flaking off at the sides, leaving a pyramidal shaped cone.

A Safety Lock for Spring Rail Frogs.

A great deal has been heard of late years about the dangers attendant upon the use of spring rail frogs. Whether there is really more risk in their use than in the use of the ordinary stiff frogs is a question on which authorities differ. Each involves risks of its own, and exact comparison is difficult; but the great advantages of the spring rail frog in economy and smoothness of track are pretty sure to keep it in extensive use. Those who are inclined to look on it with distrust and who desire to surround it with every possible safeguard may find the accompanying illustration of a lock for spring rail frogs of practical interest. The device is the invention of Mr. M. L. BYERS, Asst. Engr. Maintenance of Way Dept., Pittsburg, Cincinnati, Chicago & St. Louis R. R., and Mr. H. W. BYERS. The drawing shows it as it was applied to a main line switch at Lawrence Junction, on the Erie & Ashtabula Division of the Pennsylvania Co.'s lines.



SAFETY LOCK FOR SPRING RAIL FROGS.

The device consists merely of a rock shaft, passing under the frog between two ties as near as possible to the point where a double flange wheel would strike the wing rail in trailing the point of the frog. On the rock shaft is a collar *A*, resting against the flange of the stiff rail, and a projection *B*, on one side. When this projection points upward, it engages the flange of the spring rail, locking it firmly in place for the main track. When the projection is turned downward, the wing rail is released and the siding may be entered.

The lock is operated by means of a wire rope connection with the switch-stand. A grooved wheel is riveted to the arm of the switch-stand so that the center of the wheel coincides with the axis of the arm, and a wheel of the same size is attached to the rock shaft. A steel wire passes around both wheels and when the switch is thrown the rock shaft is turned 180°. The wires are protected by wooden coverings similar to those used for wires to distant signals.

The only objection found to the device in its use at Lawrence Junction, is that a train on the siding must keep back of the frog whenever the switch is set for the main track; but this when rightly looked at, is rather a merit than a defect. A train on the siding has no right to be obstructing the frog when the switch is set for the main line.

American Smokeless Powder.

Appended to the report of the Chief of the Ordnance Bureau is a report by Commander T. F. JEWELL summarizing the results obtained in the manufacture of smokeless powder according to methods devised by Prof. C. E. MUNROE, of the Newport Torpedo Station.

The qualities sought for were, in addition to the smokeless feature, progressive rate of burning, so that high velocities could be secured without undue strain in the gun; complete physical and chemical homogeneity, so that equal charges will always produce the same ballistic effects under similar circumstances, and permanency in its qualities during storage or when subjected to considerable changes of temperature.

The first of these qualities is obtained in many foreign powders; but they show a decided lack of homogeneity and are most deficient in the quality of permanence, due mainly to volatile constituents which evaporate and change the constitution of the powder. The tests of the powder produced at Newport have shown it to possess unusual ballistic qualities. A charge of 42 grains fired in a small calibre (.301-inch) rifle imparted to a bullet weighing 215 grains a mean observed velocity, at 60 ft. from the muzzle, of 2,100 ft. per second, with a chamber pressure of about 12 tons to the sq. in. The grade of powder adapted to the 3-pdr. rapid fire gun gave a muzzle velocity of 2,250 ft. per second, with a chamber pressure of 14.8 tons. In the 6-pdr. Hotchkiss gun a velocity of 1,920 ft. per second was obtained, with a chamber pressure of 14.3 tons. A grade of powder for the 4-in. and 5-in. guns has been manufactured, but has not yet been tried.

As to its permanent qualities, repeated heating for prolonged periods have no effect upon it, as it

* Estimated.

contains no volatile or unstable constituent. Though it will not burn when wet, it is not permanently affected by water, or even by boiling in water. A sample subjected to the action of a mixture of ether and alcohol for 5 weeks left this powder without change, though a similar treatment will break down in a short time any foreign smokeless powder examined at the station. It is not detonated by fulminate of mercury even when confined in wrought iron cylinders; it is not fired by influence, for 65 grs. of the powder placed .8 in. from a 100-gram block of gun cotton were scattered and not exploded by the firing of the cotton. These tests taken together are the most severe to which powder of this character has ever been submitted.

Paints—Their Composition and Purity.

At the last meeting of the Northwest Railroad Club Mr. J. P. SEYMOUR read a paper showing that as the chief cost in painting was the labor of application, the most durable paint is invariably the most economical. The constituent which gives durability to a paint is pure linseed oil, and no substitute such as fish oil, rosin oil, emulsions, soap mixtures and the like will give equal results. In color painting, evenness of shade is a desideratum; and it can only be obtained by fine grinding and thorough mixing. This work can best be done by the powerful machinery of paint manufacturers, hence the advantage of ready mixed paints. In buying these, however, the paste form is cheaper than the semi-liquid. Many pigments have great strength, that is a small quantity is required to stain a large amount of white lead, and yet are lacking in brilliancy. Neither of these qualities should be sacrificed for the other.

COMPOUND LOCOMOTIVES are to be tried by the Pennsylvania & Northwestern R. R. Co., which has awarded to the Baldwin Locomotive Works, of Philadelphia, Pa., an order for 10 locomotives to be used in handling the increased coal traffic of the line. They are all to be of the consolidation type and of the four-cylinder Vauclain compound pattern. The line on which they are to work has maximum grades of 158 ft. per mile and curves of 18 and 22 degrees.

THE PORT OF COATZACOALCOS, Mexico, is to be improved by the Mexican Harbor Improvement Co., represented by Mr. WM. T. PRITCHARD, according to plans prepared by Mr. E. L. CORTHELL, to give 26 ft. of water. By the terms of the concession the government pays $1,500,000 when 17 ft. is secured (4 ft. more than the present draft); $1,500,000 when 20 ft. is secured, and $1,300,000 when 26 ft. is secured; all these sums being payable in government lands at 45 to 60 cts. per hectare (2.47 acres.)

A NEW ST. LAWRENCE CANAL is to be built by the Dominion Government on the north side of that river, and commencing about 40 miles above Montreal. It would avoid the Cascade Rapids, and the estimated cost is $4,500,000.

VICKSBURG, once a flourishing river town, is now about seven miles distant from the Mississippi, that river having cut its way across the base of the peninsula that formerly fronted the city, nearly on the line of Gen. GRANT'S famous canal. The people of Vicksburg are now discussing the feasibility of diverting the Yazoo River, above Vicksburg, through the Chickasaw Bayou and into the lake now fronting the town. They think that in this way steamboats can once more be brought to their wharves.

MANNESMANN HIGH PRESSURE TUBES have been laid, by Dr. W. VON SIEMENS, for pumping petroleum a distance of 14½ miles and to a height of 3,300 ft. The pipe line runs from Baku, on the Caspian Sea, westward, is 4 ins. in diameter, and the lengths are connected by the conical screw-thread joint of the American type cut by an American machine. These Mannesmann steel tubes are laid directly on the surface, except at road crossings. The pumping pressure is nearly 90 atmospheres, and there is said to be no leakage.

THE FIRST STEAMBOAT ON WESTERN WATERS, said the venerable Mr. J. B. H. LATROBE before the Maryland Historical Society, was the *New Orleans*, which was built at and started from Pittsburg, Pa., in September, 1811, and reached the city of New Orleans in October of the same year. This boat was built from the designs of ROBERT FULTON by NICOLAS J. ROOSEVELT, who was associated in this enterprise with FULTON and Chancellor LIVINGSTON. The *New Orleans* was 116 ft. long, 20 ft. beam and had an engine with a 34-in. cylinder. The second and third steamboats built for this service were the *Vesuvius* and the *Ætna*, and the fourth boat, the *Buffalo*, was built under the direction of Mr. B. H LATROBE, Sr., the architect of the first Capitol at Washington, who became interested with FULTON and LIVINGSTON in the navigation of western waters about 1813.

THE MANCHESTER CANAL CO. is now struggling with the question of how much it will take to complete the canal. The Manchester Corporation, which has invested $15,000,000 of city money in the operation, is peculiarly interested. In January and February last the engineers of the canal company and of the corporation submitted estimates for completion. But now the first has raised his estimate $4,317,975 and the latter has raised his by $2,563,070, after deducting the modest sum of $1,752,905 allowed for contingencies in the latter case. The corporation, when too late, is vigorously advocating more economical administration.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Findlay Belt.—The cross-ties for the belt line railway at Findlay, O., have arrived, and are being distributed, and the rails will soon be on hand. The total projected length of the road is 20 miles.

Baltimore & Drum Point.—This partly graded line of railway from Baltimore to Drum Point, Md., 82 miles, has been placed in the hands of receivers, who have been directed to sell the property at auction. The company was organized in 1887, and with the proceeds of about $1,000, 00 of bonds graded a considerable portion of its line. The withdrawal of the state and county subscriptions caused a cessation of work.

Chateaugay.—Press dispatches state that surveys are being made for an an extension, or branch, of this railway to Malone, N. Y.

Lancaster, Oxford & Southern.—Slight changes are being made in the location of the portion of this line between Oxford, Pa., and Singerly, Md., to avoid heavy right of way damages. It is stated that there is a probability of the early commencement of the work.

Concord & Montreal.—It is rumored that this company will rebuild the old line from Candia, N. H., to a connection with the main line to Concord.

Grand Trunk.—The branch from Waterloo to Elmira, Ont., 11 miles, has been completed and opened for traffic.

Pennsylvania.—It is stated that this company will soon begin the surveys for a branch from Sill's Station, on the Littlestown R. R., to the battlefield of Gettysburg, and will construct the line in time for next season's traffic.—The people of Doylestown, Pa., are trying to induce this company to build a line from Philadelphia to that place.—The Wheeling, W. Va., *Register* states that 1,000 men will soon be at work on the extension from Fairchance, Pa., south.

Salem & Washingtonville.—The grading is nearly completed on the railway from Salem to Washingtonville, O.

Perry County.—Upon the completion of the extension to Landisburg, Pa., it is stated that surveys will be commenced for a further extension to Newville, Pa., where connection will be made with the Cumberland Valley R. R.

Parry Sound Colonization.—S. R. Poulin, Emsdale, Ont., Chief Engineer, writes us as follows:

About 18 miles of track are now laid on this line from Scotia, Ont., west to Parry Sound, Ont., on Georgian Bay, 48 miles, and it is expected to have 20 miles completed by Jan. 1, 1892. Only 25 miles of the line have been located, but the preliminary surveys have been completed for the remainder of the distance and location will be finished this winter. The route is through a broken and hilly country. The work is about medium; maximum grade, 53 ft. per mile, and maximum curve, 6°. The principal business of the road will be the local timber traffic and traffic from the lakes. The company was chartered in 1885. Wm. G. Reid, 30 St. John St., Montreal, P. Q., is the contractor.

Herkimer, Newport & Poland.—Articles of reincorporation of this company have been filed in the State of New York. The company operates a standard gage railway from Herkimer to Poland, N. Y., which forms a part of the new Adirondack & St. Lawrence R. R., being built through the Adirondack Mts.

Bristol.—This line from New Haven to Bristol, Vt., has been completed with the exception of a small amount of ballasting.

Projects and Surveys.

Mine Hills.—This company has been chartered in New Jersey to construct and operate railways.

SOUTHERN.—Existing Roads.

Morristown & Cumberland Gap.—An official is reported as saying that only 7 miles more of this line from Morristown to Corryton, Tenn., remain to be completed.

Terracela Phosphate Co.—This company is grading a 3¼ mile railway connecting its mines with the South Florida R. R.

Charleston, Cincinnati & Chicago.—The original holders of the $7,000,000 of bonds of this company, at their meeting at Johnson City on Dec. 5, agreed and signed a contract that the company may issue $3,000,000 preferred stock with which to pay off the present indebtedness and to complete the road. It is calculated that $1,000,000 will pay the debts and $2,000,000 will complete the road.

Charleston, Clendennin & Sutton.—A small force of men is grading this road near Charleston, W. Va. Work is now in progress on the plans and estimates for the first 20-mile section, and contracts will probably be let soon. F. W. Abney, Charleston, W. Va., President.

Murfreesboro.—This 7-mile line from Murfreesboro to Conway, N. C., is nearly completed, and will soon be put in operation.

Richmond, Nicholasville, Irvine & Beattyville.—This road has been placed in the hands of receivers. It is stated, however, that the court will probably allow the receivers to issue certificates to an amount sufficient to complete the extension from Irvine to Beattyville, Ky.

Ashley River.—It is expected that this short railway at Charleston, S. C., will be opened for traffic by Dec. 15.

Florida.—A correspondent writes the *Manufacturers' Record* that 60 miles of railway were built in this state between Jan. 1, 1891, and Sept. 30, 1891. This mileage was laid by the Silver Springs, Ocala & Gulf Ry., 15 miles, and the Ambler R. R., from Archer to mines, 45 miles.

South & North Carolina.—The Bishopsville R. R. Co. has applied to the South Carolina Legislature for permission to change its name to the above. It also asks for power to extend its line north to the North Carolina line and south to some point on the Central R. R. of South Carolina.

Watauga Valley.—The grading on this railway from Watauga to Watauga Point, Tenn., 5 miles, is about one half completed, and it is intended to lay 1¼ miles of track at once. J. R. Englebert, South Wautauga, Tenn., Chief Engineer.

Norfolk & Western.—The Ohio extension of this road will be opened for traffic from Coal Grove, O., to Dunlow, Va., 53 8 miles, on Dec. 13.

Savannah, Americus & Montgomery.—Rumors are in circulation that this company will extend its line from Lyons to Savannah, Ga., during the coming summer.

Atlantic Coast Line.—About 10 miles of the grading has been completed on the branch from Greenville to Washington, N. C., 20 miles.

Middle & East Tennessee.—It is stated that work on the 4-mile extension of this road to Hartsville, Tenn., has been begun.

Norfolk & Western.—Tracklaying is well advanced on the line connecting this road with the ore banks of the Virginia Mining & Investment Co., near Vesuvius, Va.

Baltimore, Richmond & Southern.—A bill has been introduced into the Virginia Legislature to incorporate this company with power to acquire the Richmond & Chesapeake and the Virginia & Carolina railway companies.

Projects and Surveys.

Powellton & Pocahontas.—Chartered in West Virginia to build a railway from a point near the mouth of the Armstrong Creek, Fayette Co., W. Va., to Elkhorn, McDowell Co., W. Va. Among the incorporators are: Evan Powell, President; N. J. Johnson and A. M. Campbell.

Chesterfield & Lancaster.—This company which proposes to build a railway from Cheraw to Lancaster, S. C., will soon begin securing the right of way.

Birmingham, Columbus City & St. Louis.—This company has begun the surveys for its proposed line from Guntersville to Scottsboro, Ala., before mentioned under the title of the Guntersville & Scottsboro R. R. W. E. Baskette, Chattanooga, Tenn., President.

Tavaris, Atlantic & Tampa Bay.—This company is being organized to build a railway from New Smyrna to Tavaris and Mascotte, Fla., with lines to Tampa and the phosphate regions. Among those interested are E. L. Ferran and G. A. Aber, of Tavaris, Fla.

Unaka & Nolachucky.—Work is in progress on the plans and estimates preparatory to the letting of contracts for a portion of this line. The road is projected to run from Embreeville, Tenn., to Newport, Cocke Co., Tenn., with an extension to Hot Springs, N. C.

South Carolina.—Bills incorporating the following companies have been introduced into the South Carolina Legislature: The West Shore Transportation Co., the Catawba Falls R. R. Co., the Southeast R. R. Co., and the Sumter, Lake City & Conway Ry. Co.

Arcadia, Gulf Coats & Lakeland.—A correspondent writes us that it is intended to let the contract for building a portion of this railway at an early date. President, Anthony Peters, Boston, Mass.

NORTHWEST.—Existing Roads.

Calgary & Edmonton.—Work has been stopped for the season on this railway from Calgary, N. W. T., south. Track has been laid from Calgary, N. W. T., to Mosquito Creek, 54 miles, and 50 miles from Mosquito Creek south have been graded, bringing the road to within 8 miles of MacLeod. About 700 men and 300 teams have been employed on the work during the summer under the various contractors.

Duluth & Iron Range.—This company will probably build a spur from Mesabi Station, Minn., west 10 miles during the coming season. The line will open up rich mineral lands.

Canadian Pacific.—This company has in contemplation the double tracking of its line from Winnipeg, Man., east to Ft. William, Ont., 426 miles. The work is demanded by the rapidly increasing grain traffic, and according to reports will be commenced early next season.

Davenport, Iowa & Dakota.—According to press reports there seems to be some prospect that work will be resumed on this Iowa railway during the coming summer. The road was partly graded some years ago from Davenport, Ia., north, and it is now proposed to use the old grade as far as Tripoli, Bremer Co., and thence turn west toward Clear Lake. Efforts are now being made to secure local aid,

Duluth & Winnipeg.—It is expected that the extension from Cloquet to Duluth will be completed to the St. Louis bridge, near Duluth, in about a fortnight.

Chicago, Milwaukee & St. Paul.—Press dispatches from Chamberlain, S. Dak., states that contractors are looking over the ground west of that place presumably for the purpose of making bids on the work of an extension west to the Black Hills. There are as yet few indications that any work will be done, however.

Duluth, Pierre & Black Hills.—General Manager Ward of this company is reported as saying that 60 miles of this railway at the Aberdeen, S. Dak., end and 15 miles at the Pierre end had been completed and that contracts would be let for the remainder of the line between Aberdeen and Pierre early next spring.

Projects and Surveys.

Keokuk Ry. Improvement Co.—This company has been organized at Keokuk, Ia., for the purpose of supplying switching facilities to the various roads entering the city. The capital stock is $1,000,000.

Toledo, Texas & Rio Grande.—It is stated that L. W. Burnes, a railway contractor, of East Louis, Ill., has been looking over the line of this old railway between Sailor Springs and Flora, Ill., with the view of bidding on the construction of the road. This line has been talked of for the last two or three years, but nothing further has been done.

Marinette & Western.—Surveys are to be begun at once on this proposed railway from Marinette to Abbottsford, Wis.

SOUTHWEST.—Existing Roads.

St. Louis & Hannibal.—The contractors, McDonald & Penfield, have commenced work on the line from Oakwood into the city of Hannibal, Mo., 3 miles.

San Antonio & Aransas Pass.—This company is seeking an amendment to its charter providing for an extension to Llano, Tex.

Georgetown & Granger.—The grading is practically completed on this line from Georgetown to Granger, Tex., 12 miles. The track will be laid by the Missouri, Kansas & Texas Ry. Co.

Houston & Texas Central.—Chief Engineer B. M. Temple is locating an extension from Fairland to Llano, Tex., 31 miles.

Chicago, Rock Island & Pacific.—A press dispatch from Minco, I. T., Nov. 27, says:

The surveying corps of the Rock Island road has reached here from the north and are organizing to take the field at once. They will locate a route from Minco to some point in Texas not yet made known. A former preliminary survey leads from here almost due south, striking Red River north of Bowie, Montague Co., Tex. after they locate the route they will be followed by others to establish the grade of the roadbed. It is thought a full force will be in the field shortly, and that the work of grading may commence by Jan. 1, 1892. No contracts for grading have been let up to date, as the line of the roadbed and the grades have not been fixed.

Projects and Surveys.

Missouri Southeastern.—Chartered in Missouri to build a railway from Bloomfield, Stoddard Co., northeast to a connection with the St. Louis Southwestern Ry. It is stated that the rails have already been purchased and that construction will begin at once. The officers are: Geo. H. Crumb, Poplar Bluff, Mo., President; W. S. Randall, Vice-President, and Manning S. Phelan, Secretary.

Springfield, Sedalia, Marshall & Northern.—The Ottumwa *Courier* says:

This railway is to fill in a gap between Centerville, Ia., and Springfield, Mo., the Springfield end of the line being called the Springfield & Northern. This line starts at Springfield, runs north through the towns of Buffalo, Sedalia, Marshall, ending at or near Miami in Saline Co. From that point the Brookfield & Northern takes hold. Their line starts at Miami, crosses the river at De Witt; thence to Mendon, Brookfield, Winngan, Green Castle, and on to the Iowa line; from a point on the Iowa line the Centerville people will get a charter. There is no doubt of the road being built. Several parties are waiting for the proposals and estimates before investing. The people along the entire route are in favor of the road and anxious for it to be built, offers of right of way, depots, grounds and cash being promised for the road. The promoters propose to commence construction in the spring.

Trinity, Cameron & Western.—The engineers of this road have reached Wheelock, Tex., near Hearne, on the route from Trinity, Tex., west toward Cameron.

Fayetteville & Prairie Grove.—The construction of a railway from Fayetteville to Prairie Grove, Ark., is talked of.

ROCKY MT. AND PACIFIC.—Existing Roads.

Great Northern.—The contract for the last section of the Pacific Extension from Chatteroy to Stevens Pass, Wash., 216 miles, has been let to Shepard, Seims & Co., of St. Paul, Minn. The work, which is to be completed within one year, includes the construction of a bridge 3,200 ft. long over the Columbia River at Wenatchee, at a cost of $500,000. A recent dispatch states that tracklaying from Pacific Junction, Mont., west, will be completed to Kalispell, Mont., by the end of this month, and that it will stop here for the winter. On the division from Everett, Wash., to Stevens Pass, recently put under contract, work will begin at once. This division is 80 miles long, and includes all the work on the west side of the Cascades up to the tunnel on the summit. The first work to be done will be to clear the right of way and build a corduroy road for the transportation of material and supplies. This section is to be finished by the end of 1892. The line will run along the level bottom lands of the Snohomish and lower Skykomish valleys. Along the Skykomish it will traverse a belt of dense, heavy timber, involving expensive clearing. The grading will be principally earthwork along the western end, but in the mountains there will be considerable heavy rock-cutting and some tunneling. The principal tunnel, which will be nearly, if not quite, two miles long, will probably be bored under a separate contract.

Atchison, Topeka & Santa Fe.—This company has begun the survey for a line from Cerillos to San Pedro, N. Mex., and it is stated that active construction will begin soon.

Mason County Central.—President W. H. Kneeland is reported as saying that contracts for the proposed extension of this Washington railway had been let, and that work would soon begin.

Canadian Pacific.—The surveys for the Nelson & Ft. Sheppard Ry., from Nelson, B. C., to the International line, have been stopped for the winter. It is stated that they will be resumed as soon as weather permits in the spring, and that the road will be built during the coming summer.

Southern California.—Surveys are being made for a line to close the gap between Mentone and East Highlands, Cal., 2½ miles.

Projects and Surveys.

Tacoma & Seattle Air Line.—It is stated that this road, surveys for which have been made, will be operated on the Boynton bicycle principle. The line will be about 80 miles long, and right of way is now being secured and other preparations made to begin work. F. H. Osgood, of Seattle, Wash., is President.

Drayton Harbor, Lynden & Spokane.—It is stated that the capital necessary to build this railway has been secured, and that engineers will be put in the field at once and actual construction begin by May 1. The line will run from a point on Drayton Harbor to Lynden, Wash., with branches to Sumas and Blaine, penetrating the farming lands of the Nooksack valley.

Utah & Wyoming.—John B. Taylor, of Salt Lake City, Utah, Chief Engineer, writes us as follows:

This road is projected to run from Garfield Beach, on Great Salt Lake, northeast via Edmonds, Salt Lake City, Park City and Upton, to Evanston, Wyo., a distance of 126 miles. Surveys have been completed. The work will be light; maximum grade 2.5% and maximum curve 3°. There will be one 3,700-ft. tunnel in Emigration Cañon. The principal business of the road will be in coal and other minerals, live stock and building stone. The company was chartered in August, 1891. B. G. Raybould, of Salt Lake City, is President.

Columbia River & Astoria.—An official of this company is reported as saying that construction would be begun in January, 1892. The road is to run from Goble to Astoria, Ore. W. H. Kennedy, Portland, Ore., Chief Engineer.

CITY TRANSIT.

Electric Railways.—***Newton, Mass.***—The Newton & Boston Street Ry. Co. proposes to build an electric railway, using the storage battery or overhead wire system. Mr. Joseph N. Keller is interested.

Port Richmond, N. Y.—The Port Richmond & Prohibition Park Electric Ry. Co. has been incorporated by J. H. Bogardus and Isaac Funk, of New York, and A. S. Bacon, of Brooklyn, to build a line 2 miles long. Capital stock, $50,000.

Paterson, N. J.—The Paterson Central Ry. Co. and the Central Electric Ry. Co. have been granted permission to build electric railways.

Kenosha, Wis.—An electric railway to Brassville, 4 miles, using the overhead wire system, is projected by J. W. Munson, of St. Louis, Mo.

Galveston, Tex.—The South Galveston & Gulf Shore Electric Ry. is to be built by the South Texas Const. Co.

Chippewa, Ont.—An electric railway is to be built to Queenston. For information address Mr. Wilson, Superintendent of Victoria Park, Niagara Falls, Ont.

Horse Railways.—Astoria, Blissville & Calvary Cemetery Ry. Co.; Long Island City, N. Y.; C. D. Buckingham, Brooklyn; Jacob Miller, Long Island City; Thomas A. Williams, New York; $100,000.

HIGHWAYS.

New York.—Mr. Dunton, Supervisor of Jamaica, L. I. is in favor of a macadamized road to Flushing, the cost of which is estimated at $8,000 to $10,000 per mile.

Colorado.—The following toll road companies have been incorporated at Denver: Cañon City & Cripple Creek Toll Road Co.; A. B. White, J. N. Bradbury and Robert Savage; $15,000. Ballarat & Lyons Short Line Co.; O. Burhaus, F. H. Stickney and W. E. Haxtun, $20,000.

BRIDGES, TUNNELS AND CANALS.

Bridges.—***East Chatham, N. Y.***—The old wooden bridge leading toward Canaan is to be replaced by an iron bridge.

Cumberland, Md.—The George's Creek & Cumberland R. R. Co. will build an iron bridge to replace the present Mechanic St. bridge. J. P. Gaffney, Cumberland, Chief Engineer.

Scranton, Pa.—The city engineer has been ordered to prepare plans, specifications and estimates for a new iron bridge over the Lackawanna River at Carbon St.

Ironton, O.—It is stated that the Chesapeake & Ohio Ry. Co. contemplates the construction of a bridge over the Ohio River, between this place and Russell, Ky.

Toledo, Wash.—Bids will be received until Feb. 4, 1892, for the construction of a combination bridge, 270-ft. span, with one approach 520 ft. long. Address County Auditor, Lewis Co., Wash.

WATER-WORKS.

NEW ENGLAND.

Manchester, N. H.—A petition for a high service system for the Wilson Hill section has been presented to the council.

Shelburne, Vt.—F. R. Stoddard, W. A. Weed and others have been appointed a committee to investigate the building of works.

Chicopee and South Hadley, Mass.—Q. J. Smith, H. P. Street and C. C. Abbey have petitioned for the incorporation of the Willimonsett Aqueduct Co.

Lowell, Mass.—W. D. Andrews & Bro. will sink test wells for the city.

Millis, Mass.—Henry S. Millis and others have petitioned for the incorporation of the Millis Water Co.

Pittsfield, Mass.—Mayor C. E. Hibbard has petitioned for authority to take water from Hathaway Brook.

Worcester, Mass.—Fifteen and 12-in. mains will be laid at a cost of about $2,300.

Hartford, Conn.—A 1,000,000,000-gall. reservoir may be built at an estimated cost of $100,000.

MIDDLE.

Goshen, N. Y.—The people have voted $5,000 for increasing the supply.

Ilion, N. Y.—A majority voted Dec. 1 in favor of gravity works at an estimated cost of $95,000.

Newburg, N. Y.—Col. J. D. Van Buren, Consulting Engineer, has recommended the enlargement of the supply lake by building subsidiary earth dams, the removal of muck, the construction of an open conduit 1,850 ft. long and the construction of a covered reservoir. The Water Commissioners have recommended that the lake be enlarged and the open conduit built, and some repairs and other work be done, the whole at an estimated cost of $135,550.

Ticonderoga, N. Y.—Surveys for a supply from Arthur Brook, with works to be owned by the village, are being made by D. M. Arnold, under the direction of Consulting Engineer S. E. Babcock, Little Falls. The present works are owned by a company.

Waterville, N. Y.—The people have voted to enlarge the works.

Hastings, Pa.—The Hastings Water Co. has been incorporated with James O. Patterson, Hastings, as treasurer; capital stock, $5,000, of which $500 has been paid in.

Ogontz, Pa.—It is stated that works will be built at an estimated cost of $25,000, the supply to be from a connection with the Jenkintown mains. John B. Stetson is interested.

Radnor, Pa.—The Radnor Water Co. has been incorporated, with W. S. Perot, Jr., of the American Pipe Manufacturing Co., Philadelphia, as treasurer. Capital stock, $5,000, of which $500 has been paid in. Water will be supplied to Radnor Township.

Red Lion, Pa.—An effort is being made to secure subscription for company works.

Williamstown, Pa.—New works are projected. A small plant is owned by a company.

SOUTHERN.

Atlanta, Ga.—The sum of $500,000 has been voted for the new city works.

Savannah, Ga.—Thomas T. Johnston, Chicago, Consulting Engineer for the new works, informs us that contracts have been awarded as follows: Pipe-laying, about 7,000 ft., 42 and 36-in., to Martin Cooley, Savannah; valves, 42 to 6-in., Rensselaer Mfg. Co., Troy, N. Y.

Avondale, Ala.—Works are reported as a certainty.

Mansfield, La.—It is reported that Green Rives will build the works projected.

Memphis, Tenn.—The supply is to be increased to 20,000,000 galls. capacity per day. Mr. Thomas T. Johnston, Chicago, has been engaged as Consulting Engineer.

Mercer, Ky.—It is reported that works, including a dam and reservoir, a gravel and charcoal filter, pumping station and stand-pipe, will be built by a company.

NORTH CENTRAL.

Gallipolis, O.—The village has voted to build works.

Michigan City, Ind.—Wm. Ohming, Jr., City Clerk, informs us that Mr. George S. Edmondstone has been employed to prepare plans for new city works.

Nappanee, Ind.—It is reported that James Madden, Fort Wayne, has received a contract for building works here; price, $25,000.

Portland, Ind.—Works are projected.

St. Joseph, Mich.—Remington & Co., Chicago, have been awarded the contract for constructing the new works. Two pumps, 1,000,000-galls. capacity each, will pump water from Lake Michigan through a 14-in. main to a stand-pipe 14 ft. in diameter and 100 ft. high. About 7 miles of mains will be laid and 68 hydrants set.

Cicero, Ill. (Oak Park or Chicago P. O.)—The Berwyn Water, Fuel & Light Co. has been incorporated to operate in the southern part of Cicero; capital stock, $25,000.

Marca, Ill.—Bonds for works have been voted and bids for construction will be received by the Council until Dec. 28.

Turner, Ill.—The *Democrat* says that works are needed.

NORTHWESTERN.

Centerville, Ia.—Works are again projected.

Duluth, Minn.—The council has ordered City Engineer E. H. Keating to report on such works as would be needed to supply the city in 1895.

Parsons, Kan.—A new source of supply is being considered by the company.

Deadwood, S. Dak.—It is reported that the company talks of adding pumps.

SOUTHWESTERN.

Brookfield, Mo.—Bids for constructing new city works will be received until Dec. 15.

Kansas City, Mo.—The mayor has signed the ordinance providing for the construction of works and the employment of the necessary engineers and assistants. Bids for $2,000,000 of 4½ 20-yr. bonds will be received by City Comptroller Stanley Hobbs until Jan. 1. Application for an injunction to prevent the issuance of the bonds has been made, but the legality of the proposed issue has been passed upon by the city counsellor and by special attorneys.

Yoakum, Tex.—A 40-years franchise has been granted to the Southern Improvement Co., Dallas, O. J. Gorman, Manager, for works to include a pumping station, 12×10 ft. stand-pipe, 21,000 ft. of mains and 35 hydrants. It is reported that the city will issue about $16,000 of 6% 50-year bonds as advance payment for hydrant rental during the length of the franchise.

Guthrie, Ok. T.—A Council Committee has been appointed to contract with J. W. Neir, Kansas City, for plans for works. Mr. Neir recommends a supply from the Cottonwood, to be pumped to an elevated tank.

PACIFIC.

Seattle, Wash.—The aldermen have passed an ordinance providing for the extension of a 36-in. pipe for 885 fts into Lake Washington; also for the laying of a 20-in. force main 7,400 ft. long.

Alameda, Cal.—The City Trustees have directed the fire and water committee to procure information regarding the establishment of city works. A company now supplies the city.

Sisson, Cal.—An offer to replace the 2 and 3-in. mains with 8-in. has been made by W. W. Van Arsdale.

ARTESIAN WELLS.

Harlem, Ill. (Oak Park P. O.)—Bids will be received until Dec. 19 for sinking a deep well for the village. Address George Schrade, City Clerk. G. C. Morgon, 49 Major Block, Chicago, is engineer

Blunt, Ia.—The village will soon sink a well.

IRRIGATION.

Phœnix, Ariz.—According to the Phœnix *Gazette*, T. N. Clanton and John Henry have received a contract to complete the Farmer's Canal to Aqua Frio, including six miles of new canal and the cleaning and enlarging of seven miles.

New Companies.—The Fine Gold Land & Water Co., Fresno, Cal., [$500,000; to acquire water rights, construct and operate water-works and deal in real estate and machinery. Silver Creek & Panoche Land & Water Co., Hollister, Cal.. $500,00 to; deal in water rights, construct and operate water-works.

SEWERAGE AND MUNICIPAL.

Sewers.—***New Hampshire.***—Manchester. The City Engineer says 10 miles of new sewers will probably be needed next year. The cost per mile this year has averaged $13,200. The Mayor suggests that $60,000 be raised for building sewers and $40,000 for new streets the coming year, and recommends the issue of $200,000 in bonds for this work.

New York.—Brooklyn. The contract for building sewers in Ward 2 has been awarded to Daniel J. Creem at $66,958. He was the lowest of 8 bidders.——Herkimer. Surveys are being made to ascertain the feasibility of a system.——Jamestown. An appropriation of $10,000 has been voted for surveys and specifications for the construction of sewers during the coming year.——New York. Bids will soon be asked for the Melrose Ave. sewer, 23d Ward. The total length will be 7,311 ft., of which 942 ft. will be brick sewer and the remaining from 12-in. to 18-in. pipe, with 77 manholes and 12 basins.——Norwich. The Sewer Commissioners have been appointed. T. D. Miller is President and Wm. Mason is Secretary.

North Carolina.—New Berne. A franchise has been granted to the Lewis Mercer Const. Co., of New York.

Georgia.—Brunswick. The council has voted in favor of a system of sewerage and, bids will soon be asked.——Macon. The last Congress appropriated $8,000 for building a sewer from the new government building to the river. The Supervising Architect at Washington is expected to decide soon upon the route, after which bids will be asked.

Ohio.—Columbus. Chief Inspector McDonald recommends improving the sanitary condition of the State House at an estimated cost of $100,000.

New Mexico.—Santa Fé. The City Attorney is authorized to correspond with civil engineers respecting surveys and estimates for a complete sewerage system.

California.—Redlands. Engineers Brown, Butler and Tuttle have proposed plans for a storm-water system consisting of paved and unpaved ditches to cost $100,000.——San Francisco. Engineer Manson says the city has no proper sewerage system, and flushing the present system will be of little use. The city is much stirred up upon the subject of sewers, and the mayor recommends that the next Legislature be petitioned to authorize the city to issue bonds for the construction of a complete system. He also suggests the construction of large reservoirs on the hill, into which salt water could be pumped from the bay to be used in flushing the sewers.

Streets.—***New York.***—Rochester. The Park Commission is considering a plan for the opening of a boulevard at an estimated cost of $15,000. The Common Council has passed ordinances for about $55,000 of improvements.

Pennsylvania.—Philadelphia. The Director of Public Works is arranging for $400,000 worth of paving to be done by the street railway companies during 1892.

Illinois.—Peoria. The Street Committee estimates the cost of improving Washington St. at $26,128.

California.—Redlands. City Engineer Tuttle has been ordered to prepare specifications for paving 4 blocks in the center of the city with asphalt on a concrete base.

Bonds.—Omaha, Neb.; $55,000 for paving.—Redlands, Cal.; $100,000 for storm-water system, to be voted on Jan. 5. Pittsburg, Pa.; $2,000,000 for street improvements.

ELECTRICAL.

Electric Light.—***New Britain, Conn.***—The street lighting contract has been awarded to the Electric Light Co. for 2 years at $91 per light per annum.

Newark, N. J.—Bids will soon be asked for lighting the city. The present cost is about $155,000 per year.

Orange, N. J.—The Essex County Electric Light Co. has contracted to light the streets for 5 years at $100 per light per annum.

Pittsburg, Pa.—The contract for lighting the city for 4 years has been awarded to the Allegheny County Electric Co. at $95 per light per annum for arc lights, $18 for incandescent and $17.95 for gasoline.

Mt. Pulaski, Ill.—The town has contracted with I. H. Snyder for 19 arc lights at $84 per light per annum.

Perry, Ia.—A franchise has been granted to J. M. Buker.

Pasadena, Cal.—Bids will be asked for 40 to 50 lights for 1 or 2 years.

Seattle, Wash.—The Washington Electric Light Co. has been granted a franchise. Work is to be speedily pushed to completion and $20,000 to be expended on the plant within a year.

New Companies.—Moulton Electric Light & Power Co., Torresdale Mills, Pa.; Treasurer, Henry V. Massey, Torresdale, Pa.; $1,000. Home Electric Co., New Brighton, Pa.; Treasurer, Chas. C. Robinson; $10,000. State Electric Light & Power Co.; Noah L. Cocheu, L. R. Stegman, Philip F. Lenhart, all of Brooklyn; $200,000.

CONTRACTING.

Sewers.—***Brooklyn, N. Y.***—The following were the prices of the lowest bid received for constructing a sewer on Second Ave.: Edward Gorman; 36-in. brick, $3.25 per lin ft.; 30-in. cement pipe, $2.95; 18-in., $1.55; 15-in., $1.35; 12-in., 97 cts.; 9-in., 60 cts.; manholes, $33 each; street basins, $95 each.

Streets.—***Alameda, Cal.***—The contract for macadamizing Railroad Ave. has been let to the California Improvement Co., at 7½ cts. per sq. ft. This avenue is 100 ft. wide, and has but one railway track through the greater portion of it.

Brooklyn, N. Y.—The lowest bid for grading and paving with cobble stones on North Tenth St. was that of Henry Mogk, $3.89 per lin. ft.

Paving Blocks.—***Baltimore, Md.***—The City Passenger Railway Co. has awarded contracts for Belgian blocks to be used in connection with the laying of its cable lines to R. Snowden Andrews, of the Westham Granite Co., Virginia, and to John Booth, representing New England quarries, at $1.55 per sq. yd.

Dredging.—***Brooklyn, N. Y.***—The bids for dredging Wallabout canal were as follows: C. H. Loomis, 25 cts. per cu. yd., $6,000; Henry E. Dubois, 23 cts. per cu. yd., $5,600.

PROPOSALS OPEN.

Electric Light.—***Greensboro, N. C.***—For lighting the city. Jas. W. Forbes, Mayor. Feb. 1.

Sewers.—***Boston, Mass.***—Section 22, Medford. Board of Metropolitan Sewerage Commissioners. Dec. 23.

St. Louis, Mo.—Seven contracts. President of the Board of Public Improvements. Dec. 22.

Supplies.—***Philadelphia, Pa.***—Brick, cement, cast iron, terra-cotta pipe, sprinkling wagons, broken trap rock, etc., also fencing, granolithic pavement, asphalt pavement and blocks. Russell Thayer, Chief Engineer, of Fairmount Park, City Hall, Dec. 17.

Highway.—***Chattanooga, Tenn.***—Drain pipe, dressed and rough limestone, crushed stone, gravel, also road machinery and labor for road making, including the use of horses, wagons, &c. Capt. S. C. Kellogg, Chickamauga Park Commissioner. Dec. 17.

Tools.—Machine tools, etc., for the League Island Navy Yard, Philadelphia. Edwin Stewart, Paymaster General, U. S. N., Navy Department, Washington, D. C. Dec. 22.

Public Building.—Approaches for U. S. Building at Asheville, N. C. W. J. Edbrooke, Supervising Architect, Treasury Department, Washington, D. C. Dec. 23.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Rhode Island Locomotive Works, of Providence, R. I., have built 3 mogul engines for the Columbus, Hocking Valley & Toledo. The Canadian Locomotive & Engine Works, of Kingston, Ont., have an order of 10 engines for the Canadian Pacific. The Baldwin Locomotive Works, of Philadelphia, Pa., have an order for 19 four-cylinder Vauclain compound engines of the consolidation type for the Pennsylvania & Northwestern.

Cars.—The Litchfield Car Co., of Litchfield, Ill., is building flat cars to carry the new cable cars built by the Toledo Car Co., of St. Louis, Mo., for the Third Ave. cable road in New York. The Newburyport Car Mfg. Co., of Newburyport, Mass., has built 5 electric snow plows. The Southern Pacific Co. has this year built 1,250 freight cars of 60,000 lbs. capacity. The J. G. Brill Co., of Philadelphia, Pa., has built 3 electric cars for the Tonawanda electric railway.

The Kenwood Bridge Co., of Chicago, Ill., has completed the erection of 33 roof spans of 94 ft for the Chicago Wire & Spring Co., and is furnishing about 700 tons of material for the Electrical Building for the Columbian Exposition, which includes 33 steel arches of 115 ft. span, 111 ft. high.

New Companies.—Toledo Rolling Stock Co., Toledo, O.; Sheldon C. Reynolds, Chas. L. Reynolds, A. W. Colton; $1,000,000. Western Dredging Co., San Francisco; C. E. Gunn, C. L. Benton, John Bruckman; $1,000,000. Bogart Gas Engine Co., Covington, Ky.; C. W. Bogart, Wm. Sumner, W. A. Agard; $25,000.

Metal Market Prices.—***Rails.***—New York: $30 to $30.50; old rails, $20 to $21 for iron and $14 to $15 for steel; girder rails, $40. Pittsburg: $30; old rails, $22.75 to $23.25 for iron and $17 to $18 for steel. Chicago: $31; old rails, $20.50 to $21 for iron and $15 to $16 for steel.

Track Materials.—New York: steel angle bars, 1.7 to 1.9 cts.; spikes, 2.15 to 2.25 cts.; track bolts, 2.8 to 3 cts., with square and hexagon nuts. Pittsburg: splice bars, 1.7 to 1.8 cts. for iron or steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.65 cts. with square and 2.75 cts. with hexagon nuts. Chicago: splice bars, 1.8 to 1.85 cts. for iron, 2 cts. for steel; spikes, 2.15 to 2.25 cts.; track bolts, 2.7 to 2.75 cts. with hexagon nuts.

Pipe.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 47½ per cent. on black and galvanized butt-welded; 67½ and 55 per cent. on black and galvanized lap-welded. Casing, 55 per cent.

Foundry Pig Iron.—New York: $14 to $18. Pittsburg: $14 to $16. Chicago: $14.25 to $16.

Lead.—New York: 4.25 to 4.35 cts. Chicago: 4.1 cts. St. Louis: 4 to 4.1 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 1.9 to 2.1 cts.; tees, 2.4 to 2.75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.9 to 2.1 cts. for tank, 2.15 to 2.3 cts. for shell, 2.4 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 cts.; tees, 2.5 to 2.6 cts.; universal iron mill plates, 2 to 2.05 cts.; sheared steel bridge plates, 2.1 to 2.2 cts.; refined bars, 1.8 to 1.85 cts.; steel plates, 1.95 to 2.1 cts. for tank, 2.15 to 2.2 cts. for shell, 2.35 to 2.4 cts. for flange, 3.75 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.05 to 2.15 cts.; tees, 2.4 cts.; universal plates, 2.12½ cts.; sheared steel plates, 2.2 to 2.25 cts.; steel plates, 2.2 cts. for tank, 2.6 to 3.5 cts. for shell, 2.6 cts. for flange.